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"Low Yield" Nuclear Experiments: Should They Be Permitted Within a Comprehensive Test Ban Treaty?

Lieutenant Colonel Leo Florick

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Leo Florick, Lt Col, USAF
April 15, 1996

ABOUT THE AUTHOR

Lieutenant Colonel Leo Florick is an expert on the subjects of nuclear weapons and arms control. His assignments include tours of duty as a Special Advisor to the Assistant to the Secretary of Defense for Atomic Energy, a sub-group chairman for the Nuclear Posture Review, a chief of an arms control division at the National Security Agency, a Headquarters Strategic Air Command force structure and policy analyst, and an Intercontinental Ballistic Missile combat crew commander (instructor and evaluator). He is a National Defense Fellow in the Defense and Arms Control Studies program at the Massachusetts Institute of Technology.

Lieutenant Colonel Florick's military decorations include the Defense Superior Service Medal, the Defense Meritorious Service Medal, and the Air Force Meritorious Service Medal (with two oak leaf clusters). His education portfolio includes the Air War College (Outstanding Graduate—seminar), the Armed Forces Staff College (residence), the Air Command and Staff College (seminar), and Squadron Officers' School (residence and correspondence). His academic degrees are a Master's Degree in Business Administration and a Bachelor of Arts (magna cum laude) in Mathematics.

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> "Today I am announcing my decision to negotiate a true zero yield comprehensive test ban. This is a historic milestone in our efforts to reduce the nuclear threat to build a safer world. The United States will now insist on a test ban that prohibits any nuclear weapons test explosion, or any other nuclear explosion. I am convinced this decision will speed the negotiations so that we can achieve our goal of signing a comprehensive test ban next year."
>
> \- President William J. Clinton, August 11, 1995 (36: 1)

With this concise statement, President Clinton announced a new United States nuclear weapons testing policy. After relying on nuclear testing for 47 years as a means to positively verify the reliability of the U.S. nuclear weapons stockpile, President Clinton broke with the past and set a new course supported by an integrated, six-point set of safeguards. (See Figure 1: Presidential Safeguards (Comprehensive Test Ban Treaty)) Although this dramatic announcement was very popular within nuclear disarmament circles, other communities greeted it with less enthusiasm. After evaluating the pros and cons of this "zero yield" testing provision, I believe that it will not accomplish its intended objectives. To the contrary, "low yield" nuclear experiments should be permitted within the provisions of a Comprehensive Test Ban Treaty (CTBT).

I will explain my disagreement with the national "zero yield" testing policy by sequentially stepping through the entire range of issues that bear on the problem. In its simplest form, I will examine the requirements for nuclear weapons; evaluate the alternative methods of ensuring their safety, security, and reliability; and assess the political landscape in which

PRESIDENTIAL SAFEGUARDS
(COMPREHENSIVE TEST BAN TREATY)

- SCIENCE BASED STOCKPILE STEWARDSHIP PROGRAM
  - NON-NUCLEAR EXPERIMENTS AND COMPUTER SIMULATIONS
- MODERN NUCLEAR LABORATORIES AND PROGRAMS
- BASIC CAPABILITY TO RESUME NUCLEAR TESTING
- R&D PROGRAM TO IMPROVE TREATY MONITORING
- INTELLIGENCE CAPABILITY TO GATHER INFORMATION ON WORLDWIDE NUCLEAR WEAPONS AND PROGRAMS
- "SUPREME NATIONAL INTERESTS" ESCAPE CLAUSE

FIGURE 1 (14: 1)

decisions are being made. To examine the requirement, I will discuss the national policy statements, the projected force structures, the historical arms control framework, and the provisions of the CTBT. To evaluate the alternative methods of ensuring the safety, the security, and the reliability of the stockpile, I will sequentially explore nuclear testing and Science Based Stockpile Stewardship. The chapter on nuclear testing will include the evolution of nuclear weapons, the contributions of "low yield" nuclear experiments, and the legacy of 50 years of nuclear testing. The subsequent chapter on SBSS will include the elements of the program, the long-term implications, and the likely impact on proliferation. To assess the political landscape in which decisions are being made, I will analyze the anatomy of the "zero yield" decision, the dynamics of the domestic political stage, and the impact of actors within the international

political arena. I will conclude this paper by summarizing the arguments, drawing my conclusions, and making my recommendation.

II. THE REQUIREMENT FOR NUCLEAR WEAPONS

A. ROLE OF NUCLEAR WEAPONS IN NATIONAL SECURITY POLICY

> "The highest priority of our military strategy is to deter a nuclear attack against our Nation and allies. Our survival and the freedom of action that we need to protect extended national interests depend upon strategic and nonstrategic nuclear forces and their associated command, control, and communications."
> - 1995 National Military Strategy of the United States of America (44: 10)

Since the first atomic bombs were employed against Japan and hastened the end of World War II, nuclear weapons have formed the cornerstone of the U.S. national security strategy. Even in the aftermath of the Cold War, it is clear that nuclear weapons will retain this supreme importance because of their pivotal role in deterring a weapons of mass destruction (nuclear, chemical, or biological) attack against the United States and its allies.

Although the United States is firmly committed to pursuing reductions in the world's nuclear weapon arsenals, its commitment to nuclear disarmament is "... to pursue negotiations in good faith." (47: 2-2) The second Strategic Arms Reduction Treaty (START II) establishes the force structure limits that the U.S. is planning to meet. President Clinton strongly endorsed the force structure recommendations in the Department of Defense's "Nuclear Posture Review (NPR)" and General John Shalikashvili (Chairman of the Joint Chiefs of Staff) used the National Military Strategy to state that "...we still need to maintain a survivable triad of strategic delivery systems." (44: 10) In 2003, the strategic deterrent forces of the United States will be 14 Trident ballistic missile submarines, 66 B-52 and 20 B-2 heavy manned bombers, and either 450 or 500 Minuteman III intercontinental ballistic missiles. (See Figure 2: Nuclear Weapon Delivery

NUCLEAR WEAPON DELIVERY PLATFORMS
(NUCLEAR POSTURE REVIEW)

STRATEGIC DELIVERY VEHICLES

20	B-2 BOMBERS	USAF
66	B-52 BOMBERS	USAF
500/450	MINUTEMAN III ICBMs	USAF
14	TRIBENT SUBMARINES W/ 24 D-5 MISSILES EACH	USN

TACTICAL DELIVERY VEHICLES

DUAL CAPABLE AIRCRAFT	USAF/USN
SEA-LAUNCH CRUISE MISSILES (From Attack Submarines)	USN

FIGURE 2 (45: 17, 21)

Platforms (Nuclear Posture Review)) These weapon systems will meet the START II force structure limits. Signed by President Bush and President Yeltsin in 1993, the U.S. Senate ratified this treaty in 1995. The last required approval before it enters into force is ratification by the Russian Duma. That action is entwined in domestic Russian politics and the June 1996 Russian presidential election. In addition to these strategic delivery platforms, the United States Air Force and the United States Navy will maintain a force of "dual capable aircraft (DCA)" that are certified to deliver both nuclear and conventional gravity bombs. The Navy also will maintain the capability to deploy Tomahawk Land-Attack-Missiles (TLAM(N))--equipped with nuclear weapons—on nuclear powered fast attack submarines (SSNs).

There are seven unique weapon designs in the enduring nuclear weapon stockpile that will support these strategic and tactical delivery platforms. (See Figure 3: Nuclear Weapons in

NUCLEAR WEAPONS IN THE ENDURING STOCKPILE

WEAPON	DELIVERY METHOD	ENTERED STOCKPILE	SERVICE	SAFETY FEATURES
B61	GRAVITY BOMB	68, 75, 77, 79, 85	AF, NAVY	B
W76	SLBM REENTRY VEHICLE	78	NAVY	C
W78	ICBM REENTRY VEHICLE	79	AF	C
W80	CRUISE MISSILE WARHEAD	80, 84	AF, NAVY	B
B83	GRAVITY BOMB	83	AF	A
W87	ICBM REENTRY VEHICLE	86	AF	A
W88	SLBM REENTRY VEHICLE	89	NAVY	C

SAFETY FEATURES: A--(ENDS, IHE, FRP) B--(ENDS, IHE) C--(ENDS)

- ENDS: Enhanced Nuclear Detonation Safety
- IHE: Insensitive High Explosive
- FRP: Fire Resistant Pit

FIGURE 3 (8: Table 1) & (15: C-12) & (49: 6)

the Enduring Stockpile) Most U.S. nuclear weapons were designed for a 20 year lifetime. As a result of new weapons being introduced into the deployed inventories, the average age of the stockpile has never approached this 20 year benchmark. The current average age is 13 years. In the enduring stockpile, the average age will increase by approximately one year per year. It will reach 20 years in 2004. At that time, the oldest weapons will be 35 years old. (47: 2-4)

Realizing that other nations also possess nuclear weapons, it is important to say a few things about their stockpiles in order to frame the discussion on what is the proper permitted testing provision for the CTBT. (See Figure 4: Nuclear Weapon States) Since nuclear weapons will be part of the national security landscape for the foreseeable future, the CTBT must not create an unsafe, unsecure, or unreliable condition for any of the stockpiles. Given the different levels of technical sophistication (robustness of weapon designs, experimental capabilities,

analytical capabilities, production capabilities, remanufacturing capabilities, etc.) of the nuclear weapon states, this is a very real concern. When compared to the other nuclear weapon states, some experts believe that "the U.S. is clearly ahead in readiness for a test ban." (15: 4) However, this assessment is not universally accepted. (11)

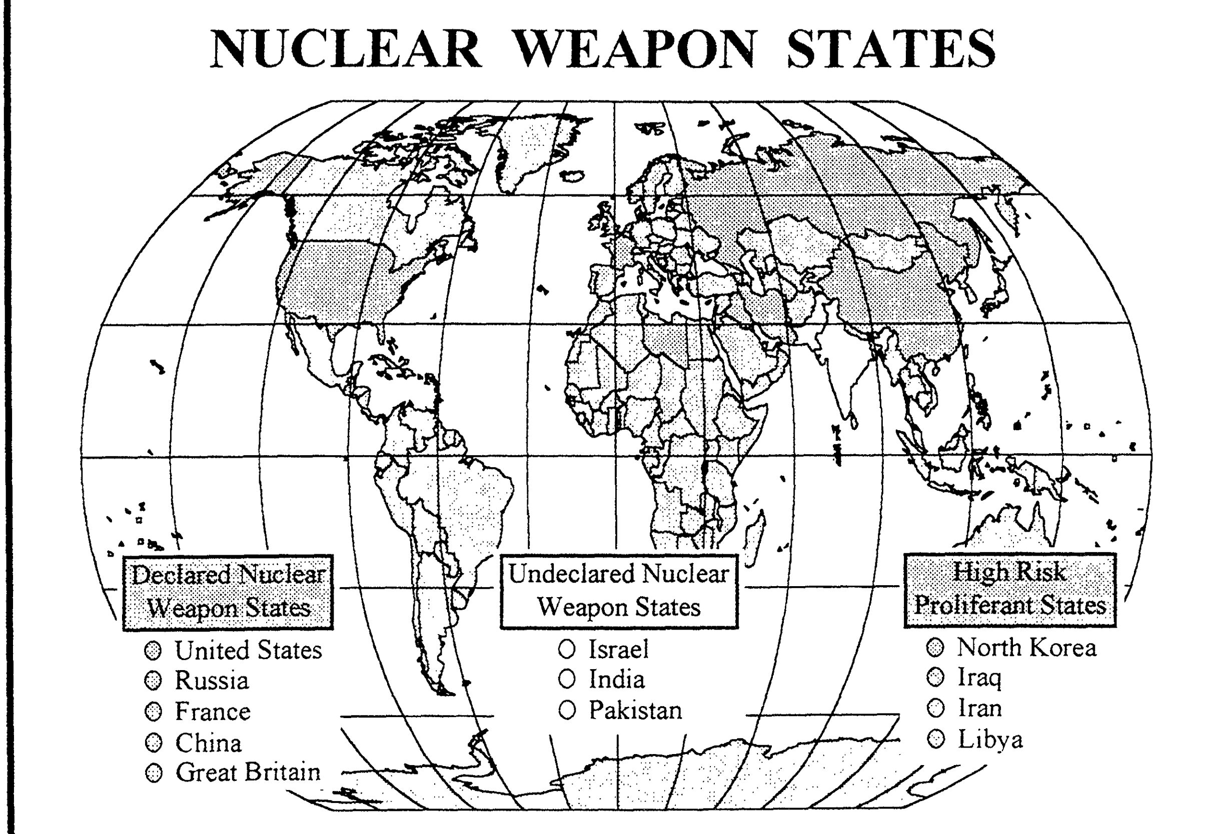

FIGURE 4 (31: Section 7.1, paragraph 1)

When considering the five declared nuclear weapon states, the United States and Russia are the primary players with respect to treaties that restrict the sizes of their strategic nuclear stockpiles. However, this description is slightly misleading because historically the treaty limited items are not the strategic nuclear weapons, but the number of nuclear weapons that the strategic nuclear delivery vehicles (heavy manned bombers, intercontinental ballistic missiles, and submarine-launched ballistic missiles) are attributed as able to carry. At present, both the

United States and Russia are reducing force structure and carriage capabilities to the START I limit of 6,000 deliverable nuclear weapons. However, because non-ALCM (air-launched cruise missile) capable bombers are attributed with a weapon loading factor of one, each side can retain additional deliverable strategic nuclear weapons that are not reflected in the total. The incentive for heavy manned bombers with gravity weapons was negotiated because these systems were viewed as less destabilizing than other prompt, non-recallable delivery systems. In addition to these strategic weapons a much smaller number of tactical nuclear weapons, operational spare weapons, and replacement weapons for units that are examined but cannot be returned to the active stockpile will be retained. If START II is ratified by the Russian Duma, the number of permitted strategic nuclear weapons will be reduced to between 3,000 and 3,500. (23: 29) As with START I, this limit does not include tactical nuclear weapons, operational spare weapons, and replacement weapons for units that are examined but cannot be returned to the active stockpile. Unlike START I, however, START II removes the bias toward heavy manned bombers with gravity weapons by attributing ALCMs, gravity bombs, and SRAMs (short-range attack missiles) equally. (27: 10) Assuming that START II is ratified at some point in the near future, both the United States and Russia must reduce their forces to the 3,000-3,500 limit by the year 2003. For the purposes of this paper, one should assume that the sizes of the U.S. and Russian nuclear stockpiles are comparable. One is not significantly larger or smaller than the other.

From largest to smallest nuclear weapon stockpiles, France, China, and Great Britain are the remaining declared nuclear weapon states. For the purposes of this paper, one should assume that each of them has approximately 500 or fewer nuclear weapons. (6: 1) Russia, China, and

France have their own underground nuclear testing facilities/sites. Great Britain used the U.S. facilities at the Nevada Test Site to conduct its underground nuclear tests.

The frequently acknowledged, but officially undeclared nuclear weapon states are Israel, India, and Pakistan. Israel is thought to have approximately 200 nuclear weapons. Both India and Pakistan are thought to possess only a few nuclear weapons. (30: 2) The Indian and Pakistani weapons may or may not be assembled. However, assembling the components into weapons would not be a time consuming process.

With respect to the eight declared and undeclared nuclear states, there is no reason to believe that any of them will eliminate their nuclear weapons stockpiles. The declared nuclear states can be expected to fully comply with their treaty obligations. If more restrictive treaties are concluded and ratified, these lower limits will be met. However, all of them can reasonably be expected to act in their national security interests. It is for this reason that France and China conducted their most recent underground nuclear tests. The following sentiments of Mr. Jean-Marie Le Pen (Leader, Extreme-Right National Front) are not uncommon: "France has not surrendered with its hands and feet bound to the dictates of foreign governments or the threats of the anti-military lobby. France should carry out however many tests it takes to perfect laboratory simulation of nuclear explosions to keep the French deterrent credible." (7: 6)

The nations that are most often mentioned as interested in acquiring nuclear weapon capabilities are North Korea, Iran, Iraq, and Libya. The two recognized means by which they might acquire nuclear weapons are producing them indigenously and purchasing them from another source. The "home grown" versus "imported" question pertains to assembled nuclear weapons, fissile materials, nuclear weapon technologies, and nuclear weapon design expertise. In the wake of the dissolution of the Soviet Union and the collapse of its very tight controls on

its nuclear programs—military and civil—the threat to the West posed by "nuclear imports" has grown substantially.

B. NUCLEAR ARMS CONTROL TREATY STRUCTURE

In spite of the proliferation histories of North Korea, Iran, Iraq, India, Pakistan, Israel, and South Africa, the family of bilateral and multilateral nuclear arms control treaties has been

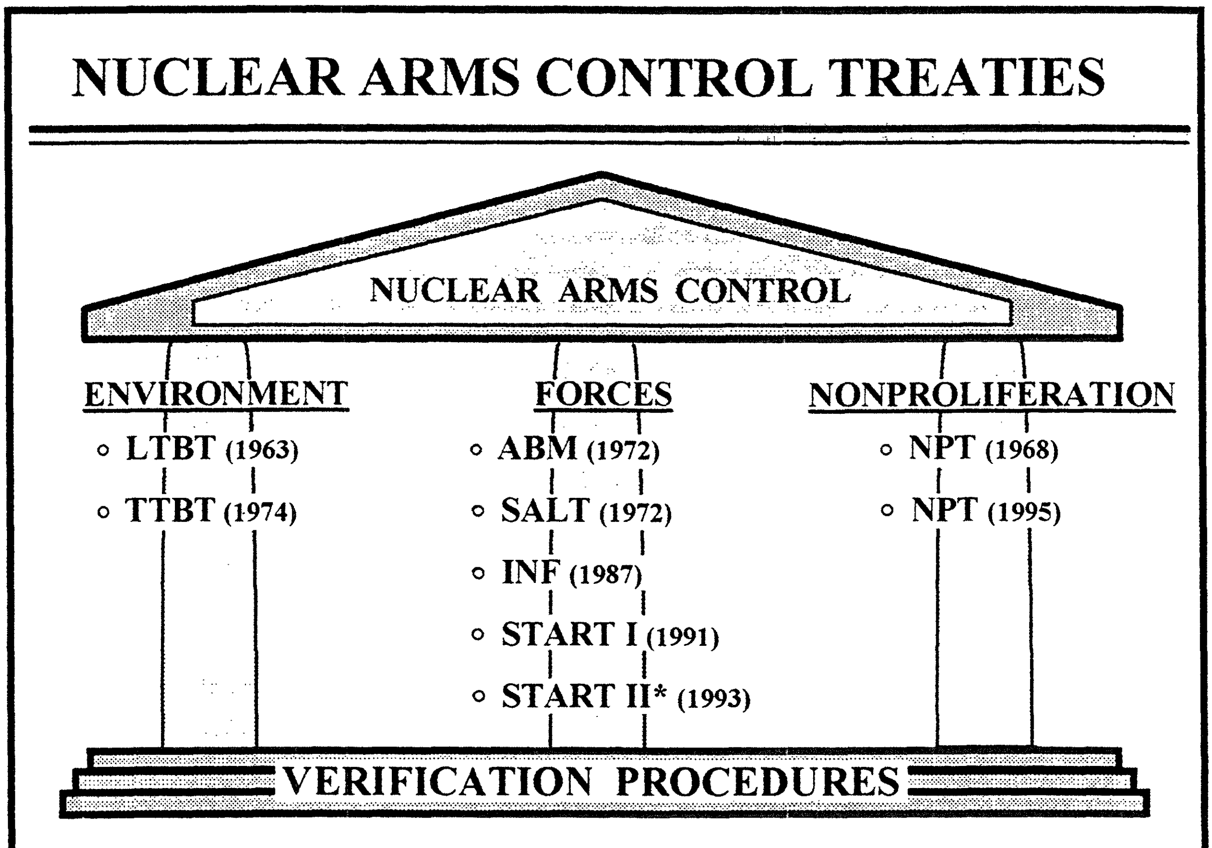

FIGURE 5 * Ratified by U.S., awaiting Russian ratification

successful in controlling damage to the environment, reducing the number of deployed nuclear weapons, and limiting the proliferation of nuclear weapons. (See Figure 5: Nuclear Arms Control Treaties) Although provisions of the various treaties differ significantly from one another, the treaties share the common aim of lessening the threats that nuclear weapons pose.

Additionally, each treaty is firmly grounded on realistic verification procedures and protocols. These procedures and protocols reduce the likelihood of a signatory "breakout" scenario by increasing the probability that meaningful treaty noncompliance will be detected, identified, and mitigated. Although the treaties that have entered into force do restrict the nuclear programs of the declared nuclear states, it must be remembered that none of them require nuclear disarmament. Eventual nuclear disarmament is only a goal.

Initial nuclear arms control successes emphasized controlling damage to the environment by restricting nuclear tests. This was accomplished by eliminating mediums and regions in which tests could be conducted and by limiting the explosive power of permitted underground nuclear tests. The Limited Test Ban Treaty (LTBT) of 1963 and the Threshold Test Ban Treaty (TTBT) of 1974 are the major accomplishments in this category. Under the provisions of the LTBT, nuclear tests were prohibited in the atmosphere, in space, and in the oceans. (42: Article I) The "original parties" to this treaty were the United States, Great Britain, and the Soviet Union. Under the provisions of the TTBT, the explosive power of underground nuclear tests was limited to 150 kilotons of TNT. (32: 1) The "original parties" to this treaty were the United States and the Soviet Union. The Antarctic Treaty of 1959, the Treaty for the Prohibition of Nuclear Weapons in Latin America and the Caribbean of 1967, and the South Pacific Nuclear Free Zone Treaty of 1985 are examples of treaties that banned nuclear tests in regions of the world. For this functional category of nuclear treaties monitoring stations throughout the world—focused primarily on seismic activity—form the basis of the verification schemes. These verification technologies are very capable at detecting large yield detonations.

By the shear volume of ratified treaties, the category of arms control that has received the most attention is limiting force structure, i.e. the number of bombers, ballistic missiles,

submarines, and launch facilities. The Anti-Ballistic Missile (ABM) Treaty of 1972 restricted the number of deployed anti-ballistic missiles for the United States and Soviet Union. The Strategic Arms Limitation Treaty (SALT) of 1972 set a ceiling for strategic delivery platforms to which the United States and Soviet Union could build. Both the ABM and SALT treaties relied on "national technical means" as the primary means of verification.

The Intermediate-Range Nuclear Forces (INF) Treaty of 1987 successfully eliminated an entire class of nuclear weapon delivery platforms for the United States and the Soviet Union. The United States destroyed its Ground-Launched Cruise Missiles (GLCMs) and Pershing II missiles. The Soviet Union eliminated its SS-20 missiles. The intrusive verification procedures of the INF Treaty raised this critical aspect of arms control to a higher level of confidence building. For the first time in the nuclear age, frequent on-site inspections and portal perimeter monitoring stations (PPMS) meant that treaty signatories would not need to rely primarily on national technical means to verify treaty compliance. The INF Treaty established a precedent by which all future treaties will be judged. However, with all of the positives of these verification measures, they were very expensive. Each nation had only one PPMS site on its territory. The U.S. site was located at Magna, Utah and the Russian site was at Votkinsk, Russia. It did not take very long before cost considerations led the Russians to waive some of their inspection rights. Although on-site inspections and PPMS were dramatic successes, they did have their limits. They may not be the correct solutions for every situation.

Similar to the INF Treaty, the Strategic Arms Reduction Treaties of 1991 (START I) and 1993 (START II) relied on intrusive inspection procedures. The START I treaty was the first time that the United States and Russia agreed to reduce their strategic weapon delivery platforms. (22: START Supplement 4) The SALT treaty limits had been set as high or higher

than the existing forces. In light of this significant accomplishment, effective and affordable verification procedures were absolutely essential. Both the United States and Russian have signed the START II treaty. However, only the United States has ratified it. Positive action by the Russian Duma is problematic and is linked to domestic political developments.

The Nonproliferation Treaty (NPT) of 1968 is the most noteworthy achievement within the general category of treaties that discourage the proliferation of nuclear weapons. During its existence, 178 of the 185 nations in the United Nations signed the NPT and agreed to its conditions. North Korea, Iran, Iraq, and Libya signed the treaty but as mentioned previously, are believed to have pursued nuclear weapon capabilities. India, Israel, and Pakistan have not signed the NPT. (31 Section 7.1, paragraph 1) A major foreign policy success of 1995 was the indefinite extension of the NPT that President Clinton so eloquently championed. It culminated five years of planning and lobbying led by the Arms Control and Disarmament Agency. (13: 3) Non-nuclear capable signatories to the NPT pledged to forego nuclear weapon development programs. As a quid pro quo for this commitment, Article VI of the NPT obligates all parties "...to pursue negotiations in good faith on effecting measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control." (43: 3) However, this is an open-ended goal that does not have a corresponding mandatory completion date.

The NPT disarmament pledge should be viewed in a context similar to the Israeli pledge to disband its nuclear weapon program once the threat to Israel is no longer present. In light of Iraqi, Iranian, and Libyan policies, Israeli nuclear weapon disarmament will probably be a very long time in coming.

As major of an accomplishment as the NPT was, it must be remembered that even with it, numerous states either developed or pursued nuclear weapons. Except for the security risks that these nuclear capable states pose, the beauty of the NPT is that it does not simultaneously impose restrictions on the United States that will call our nuclear deterrent forces and capabilities into question. Therefore, these emergent nuclear states must consider a fully capable U.S. nuclear deterrent in their calculations of whether or not to use their nuclear weapons. As pressures increase to reduce defense budgets and force structures, a situation analogous to nuclear weapons in NATO countering superior conventional Warsaw Pact forces may develop. Reduced conventional forces may result in an even more important role for nuclear deterrent forces. This would not only apply to U.S. military capabilities, but to the other declared nuclear states as well.

Throughout the period that the NPT has been in effect, the United States has used its most capable intelligence gathering tools to monitor suspected nuclear weapon development programs. However, even after extended efforts to learn more about these programs, there is a vast amount of information that remains hidden from view (e.g., revelations about the extent of the Iraqi nuclear program). Therefore, one should not assume that the U.S. possesses monitoring capabilities that do not exist.

C. COMPREHENSIVE TEST BAN TREATY

> SCOPE: "Each State Party undertakes [to prohibit, and to prevent, and] not to carry out, [at any place and] [in any environment,] any nuclear weapon test [explosion] [which releases nuclear energy], or any other nuclear [test] [explosion]], or any release of nuclear energy caused by the assembly or compression of fissile or fusion material by chemical explosion or other means,] [and to prohibit and prevent any such nuclear explosion] [at any place under [or beyond] its jurisdiction or control]." (48: 43)

The Comprehensive Test Ban Treaty seeks to build on a remarkable series of successes within the international arms control arena. At first glance, it complements and completes the achievements of the Threshold Test Ban Treaty by prohibiting the underground nuclear tests --with an explosive power under 150 kilotons equivalent TNT—that the TTBT permitted. On closer examination, however, the CTBT is many things to many people—not necessarily the same things. At this time, these different viewpoints are clearly shown by the approximately 1200 bracketed items in the draft treaty text. The battle is over the body and soul of the CTBT. Will it be a threshold test ban with "low yield" experiments or will it be a comprehensive test ban without any nuclear tests or experiments?

> "[Affirming that effective measures of nuclear disarmament...have the highest priority, that the early realization of complete prohibition and thorough destruction of nuclear weapons is the common goal of the international community, and that to this end, it is imperative to remove the threat of nuclear weapons, to halt and reverse the nuclear arms race until the total elimination of nuclear weapons,...,and to avoid the proliferation of nuclear weapons in all its aspects.]" (48: 41)

This bracketed text reveals that the fundamental issue of the CTBT debate is whether or not nuclear disarmament is the logical next step. The nuclear disarmament theme runs throughout the draft document. India is leading the effort to require the declared nuclear states to commit to nuclear disarmament. This is a commitment that the nuclear states are unwilling to

make. During a briefing on nonproliferation issues, Mr. John Hollum (Director, U.S. Arms Control and Disarmament Agency) said, "Within the terms of a comprehensive test ban, we will continue activities that are necessary to assure the safety and reliability of the [U.S.] stockpile... [The CTBT] is not a determination in itself to abolish nuclear weapons." (28: 3-4) The declared nuclear states view the CTBT as a freeze on the development of "new" weapon designs. Although the United States dropped the "Little Boy" atomic bomb on Hiroshima without conducting an operational test of the device, modern nuclear devices are so complicated that one can assume that the probability of a declared nuclear state placing a "new" nuclear weapon design in their stockpile without successfully completing a large-scale, underground nuclear test is low. However, it must be remembered that a "new" weapon could be introduced that is based on a simplified physics design or an "on the shelf" design that was previously tested but never weaponized. The same "low probability" assessment cannot be confidently made when the situation involves a proliferant nation, a covert nuclear weapon program, or a basic weapon design. (20)

During the nuclear age, there were two periods during which nuclear states voluntarily imposed testing moratoriums on themselves. The United States, Russia, and Great Britain agreed to a testing moratorium that lasted from 1958 to 1961. During this period, the three nations worked toward achieving a test ban treaty that eventually evolved into the Limited Test Ban Treaty of 1963. However, the United States, Russia, and Great Britain resumed testing because of its pivotal role in their nuclear weapon programs. In the early 1990s, Russia (1990), France (1992), the United States (1992), and then Great Britain (1992) stated their intentions to temporarily suspend underground nuclear testing while they evaluated their respective nuclear programs and explored the possibility of a more restrictive nuclear test ban regime. China did

not agree to join the moratorium. (30: 1) While the United States, Russia, and Great Britain adhered to the moratorium, first China and then France resumed underground testing. France concluded a series of six underground tests and announced that it was re-imposing a testing moratorium on itself.

Following President Clinton's announcement of a "zero yield" test ban, France announced its support "in part to blunt the extreme criticism it faced for resuming nuclear testing in the Pacific." (18: 4) Great Britain prefers a "low yield" threshold, but reluctantly conceded to "zero yield." (18: 4) As with Great Britain, Russia prefers a "low yield" threshold. "Russian laboratory directors...clearly do not want any kind of a test ban and are quite open about it." (18: 4) China announced its support for "zero yield" but desires a provision that excludes peaceful nuclear explosions from the treaty. This exclusion would provide a loophole that would effectively negate the "zero yield" CTBT since "there is no difference between peaceful nuclear explosions and those done for military purposes. (18: 4)

"Trust—but Verify!" These three little words spoken by President Ronald Reagan may be his most famous quotation. It can be argued very successfully that these sentiments formed the basis for a decade of arms control breakthroughs—the Intermediate-Range Nuclear Forces (INF) treaty, the Strategic Arms Reduction Treaties (START I & II), and the Conventional Forces in Europe (CFE) treaty. The common thread that winds throughout these accomplishments is accurate, unambiguous, and timely verification procedures that promote treaty compliance by preventing undetected treaty violations. The standards for verification that the U.S. Senate has applied in recent years "require as a minimum that: a) no violation that could endanger national security should remain undetected and unidentified, b) a violation should be identified in sufficient time to allow remedial action to protect national security, and

c) no violation that interferes in a basic way with the essential purposes of the treaty should remain undetected and unidentified." (32: 3) Without these "trust enabling" procedures, the treaties would have been considerably more difficult to negotiate, to sign, and to ratify.

Within the negotiation framework of the CTBT, all language concerning verification is bracketed as a result of either procedural reasons or differences of opinion among delegations. However, five general categories are being examined for inclusion within the verification regime. The categories are: a) an international monitoring system, b) consultation and clarification, c) on-site inspections, d) national or multinational means of verification, and e) confidence-building measures. (48: 66) If signatories are not confident that the other signatories are complying with the requirements of the CTBT treaty, then they will be less likely to comply themselves.

> "...the most effective way to achieve an end to nuclear testing is through the conclusion of a universal and internationally and effectively verifiable comprehensive nuclear-test-ban treaty [within the framework of an effective nuclear disarmament process] that will attract the adherence of all States and will contribute to the prevention of the proliferation of nuclear weapons in all its aspects, to the process of nuclear disarmament and therefore to the enhancement of international peace and security" (48: 41)

Unfortunately for the CTBT, the verification goal is absolutely unreachable. The "zero yield" provision requires that no explosive nuclear tests are conducted. The very serious problem with this total ban is that the lower limit to confidently detect a nuclear test is approximately one kiloton equivalent TNT. To make matters worse, a nuclear device can have an explosive power greater than one kiloton if decoupling technologies are employed to mitigate shock wave transmission into the surrounding ground. (11) The one kiloton limit is the net

effect of energy transmitted into the ground. It is not the gross measurement of a weapon's explosive power.

I discussed this problem with Dr. Ted Postol (Professor, Massachusetts Institute of Technology) and Mr. Ronald Cosimi (Test Director, Los Alamos National Laboratory). Both stated that they believed that a nation could keep a covert nuclear weapon development program hidden from other nations. This would be easier for a proliferant nation than for one of the declared nuclear states. However, Dr. Postol amplified his answer by stating that he believes proliferant nations have neither the capability to conduct a test below the one kiloton level or employ decoupling techniques to reduce the net shock effects of a larger yield underground test. (33) With an opposing judgment, Mr. Cosimi stated that he believes that some proliferant nations—with capabilities similar to those of North Korea—could both conduct a test below the detectable limit and use decoupling techniques if required. (11) In either case, both Dr. Postol and Mr. Cosimi said that if a test had an explosive power of less than one kiloton, it would be undetectable. Although these are the judgments of only two men in the field, none of the other nuclear testing experts that I spoke with had a different assessment of the detectability of an underground test less than one kiloton. An additional verification problem is the uncertainty that is introduced as a result of differences in test site geology. (32: 3) Porous ground conditions dampen shock waves more efficiently than solid rock. Therefore, knowledge of local geology in proliferant nations is very important to confidently detecting non-compliant actions.

Even President Clinton stated, "I recognize that our present monitoring systems will not detect with high confidence very low yield tests. Therefore, I am committed to pursuing a comprehensive research and development program to improve our treaty monitoring capabilities

and operations." (34: 2) Although the President made a positive statement on seeking to improve treaty monitoring capabilities, his "committed to pursuing" words did not convey a confidence that the capabilities will ever be developed to verify a "zero yield" testing provision. Based on this very significant inability to detect and to identify a covert underground nuclear test, the "zero yield" provision is not verifiable and does not satisfy the entering verification requirement as specified in the CTBT preamble.

D. CHAPTER HIGHLIGHTS

Nuclear weapons are integral parts of the national security strategies of the United States and the other declared nuclear weapon states. None of them has given any indication that they are prepared for nuclear disarmament.

The Comprehensive Test Ban Treaty is the latest in a 30 year history of arms control agreements. However, the United States must be cautious in order that the CTBT does not create unsafe, unsecure, or unreliable conditions in any of the world's nuclear weapon stockpiles. Neither the nuclear weapon technologies nor the assessment and evaluation technologies of the nuclear states are equivalent. Additionally, the arms control successes have been based on accurate, unambiguous, and timely verification procedures that promote treaty compliance by preventing undetected treaty violations. The "zero yield" provision that the current administration is pursuing is not verifiable. The lower limit to confidently monitor underground nuclear activity is approximately one kiloton equivalent TNT.

III. TECHNICAL CONSIDERATIONS OF NUCLEAR TESTS AND EXPERIMENTS

A. NUCLEAR WEAPON DESIGNS

Modern nuclear weapons are considerably more powerful and more complex than the earliest atomic weapons employed against Hiroshima ("Little Boy") and Nagasaki ("Fat Man") in August 1945. They "operate at conditions that are virtually unique—at material velocities of millions of miles per hour, under temperatures and pressures that are hotter and denser than the center of the sun, in time scales as short as a few billionths of a second." (26: 4) Throughout the nuclear weapon era, operational requirements drove weapon designers to minimize weapon weight and volume while simultaneously maximizing weapon yield. As a result of this constant push to maximize the yield-to-weight ratio, nuclear weapons were precisely engineered to very tight tolerances with minimal margin for degraded subsystem performance. Weapons were designed to be replaced before aging effects developed into serious problems. For a modern nuclear weapon to perform properly, each of its subsystems must work as required.

Nuclear weapon designs were further complicated by the need to increase safety and security. During an accident or a mishap, the radioactive fissile materials must be contained. In addition to working when required, nuclear weapons must not operate when not authorized. This includes both accidental situations and deliberate attempts to detonate a device. Modern nuclear weapons contain many safety and security features. However, all of the weapons in the enduring U.S. nuclear weapon stockpile do not meet the modern safety design criteria standards

of enhanced nuclear detonation safety (ENDS), fire resistant pits (FRP), insensitive high explosive (IHE), and use control. (4) (See Figure 3: Nuclear Weapons in the Enduring Stockpile) Enhanced nuclear detonation safety systems protect against premature arming and detonation by isolating electrical elements critical to detonation. (12: 19) Fire resistant pits reduce the likelihood of plutonium dispersal in a fire accident. FRPs have a metal shell with a high melting point that can withstand prolonged exposure to a jet fuel fire without failing. (12: 26) Insensitive high explosives possess a unique insensitivity to extreme, abnormal environments. IHE reduces the danger that an accident or incident would cause the detonation of the high explosive surrounding the weapon primary (e.g., railroad car accident during weapon transport). (12: 21) Use control systems prevent unauthorized use of a nuclear weapon while simultaneously permitting authorized use.

The earliest atomic weapons were single-stage devices of relatively simple designs. Although they used different mechanisms to achieve their intended results, fissioning heavy elements was their underlying principle. The two methods used to achieve fissioning were bringing two separate subcritical masses together and compressing one subcritical mass. (See Figure 6: Early Atomic Weapon Designs) In both cases, the result was a sufficient amount of fissile material in a small enough volume for fissioning to occur. Once the physics was understood, the most difficult aspect of building these early weapons was producing sufficient quantities of the required fissile materials that do not occur naturally. Although weight and volume were considerations for these weapons, they were delivered by large strategic bombers. Therefore, these factors were not as important as they would become with the introduction of missile delivery systems (i.e., intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs), and cruise missiles).

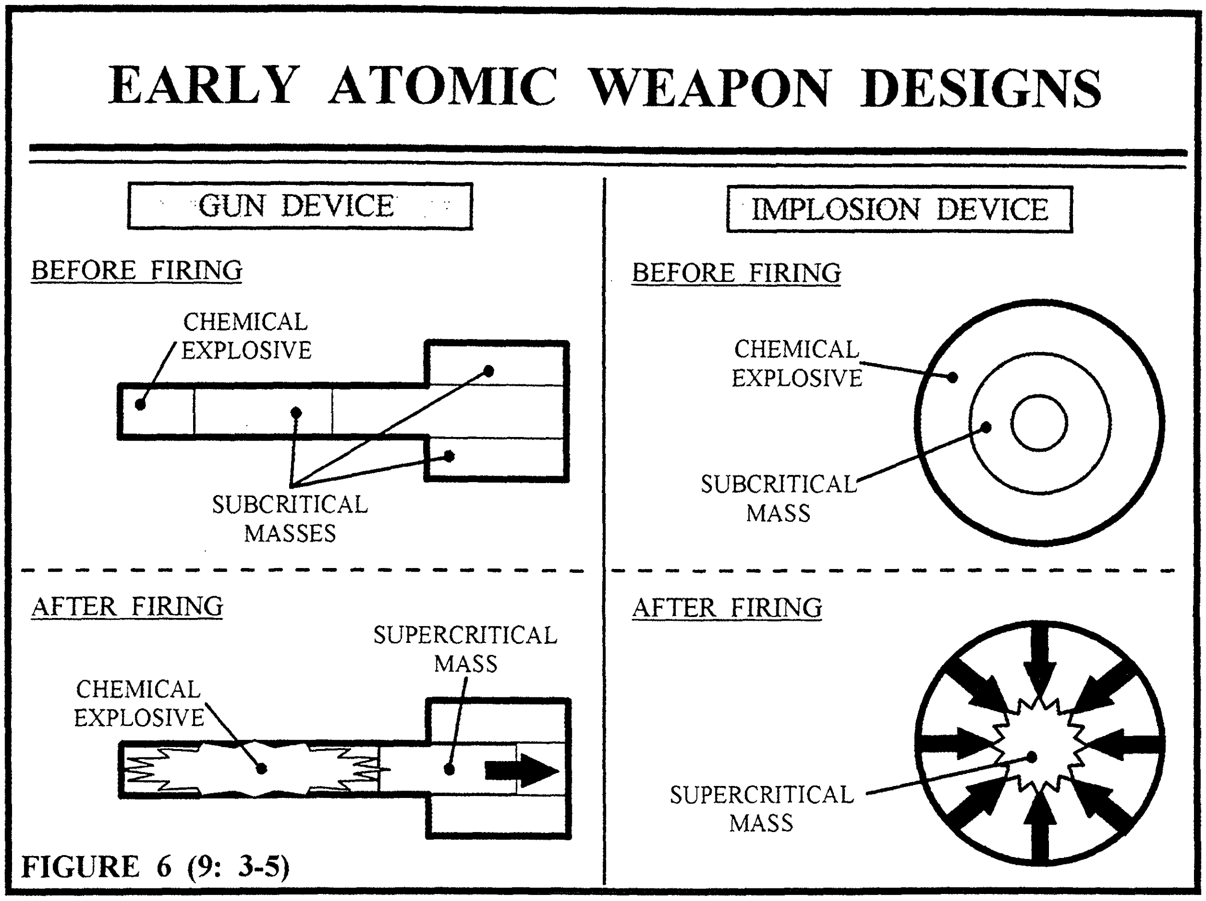

FIGURE 6 (9: 3-5)

Unlike the earlier designs, most modern nuclear weapons are two-stage devices that sequence a fission reaction of a very heavy element with a subsequent fusion reaction of a light element. In essence, these weapons are two nuclear devices strapped together. (See Figure 7: Thermonuclear Weapon Design) Like the earlier single-stage weapons that used high explosives to achieve criticality, these weapons start with that type of explosion for the first stage—also called the "primary." However, the second stage—also referred to as the "secondary"--is compressed by the nuclear effects of the exploding first stage. This is a very complicated sequence of events because the weapon must remain intact while the exploding first stage drives the unexploded second stage to criticality. (20)

THERMONUCLEAR WEAPON DESIGN

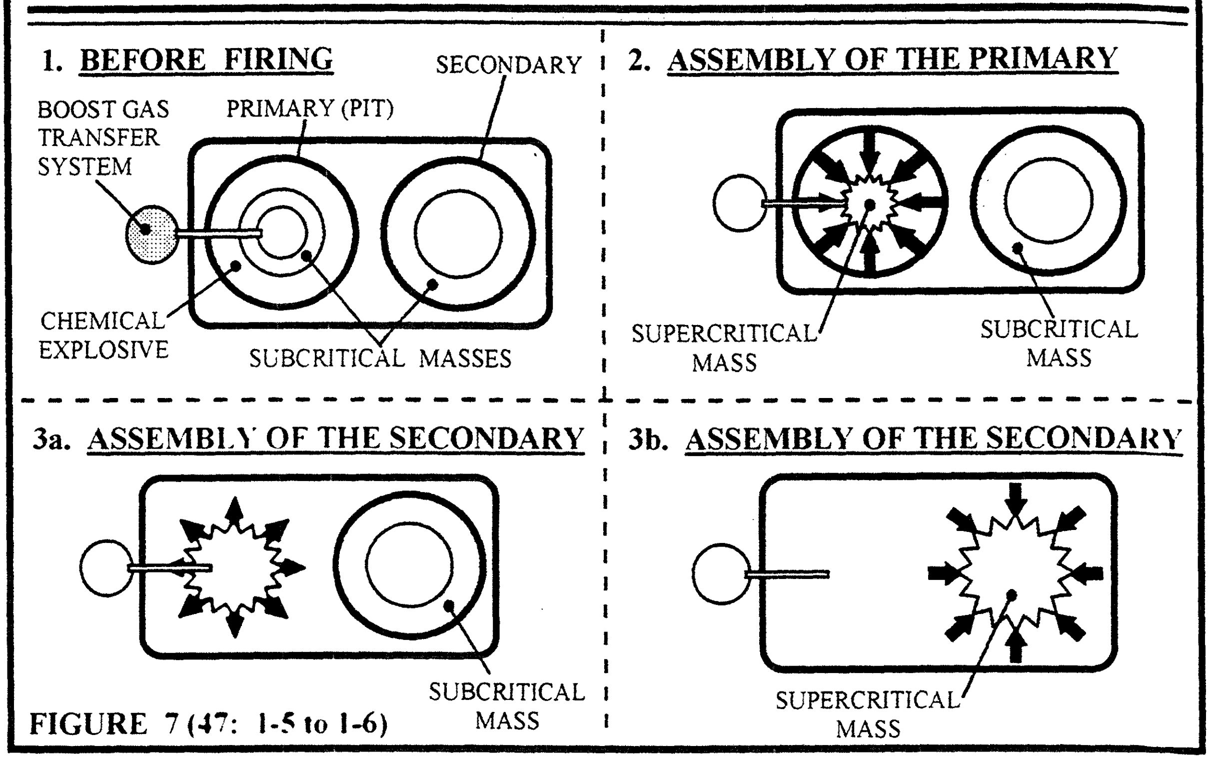

FIGURE 7 (47: 1-5 to 1-6)

B. WHAT ARE "LOW YIELD" NUCLEAR EXPERIMENTS?

There are two categories of "low yield" nuclear experiments. (20) Both categories are conducted as underground experiments. The first category has a maximum equivalent explosive power of four pounds of TNT or less. These experiments are referred to as hydronuclear experiments. Although fissile materials are involved, only a small amount of energy is released. These experiments were conducted primarily to determine the "one point safety" or "multipoint safety" of a nuclear weapon design. The one point safety criteria states, "In the event of a detonation initiated at any one point in the high explosive system, the probability of achieving a nuclear yield greater than four pounds TNT equivalent shall not exceed one in one million

(1×10^{-6})." (12: 14) This type of problem was discovered previously in weapons in the stockpile. These experiments are not conducted to better understand the explosive nuclear physics of the weapon design. They insure that the device will not go critical if it is subjected to a shock wave. Current computer models can predict some one-point safety hazards. However, they are inadequate at performing three dimensional, multipoint safety calculations. Current computer models are not reliable enough considering the potential serious consequences of an unintended detonation.

The second category of "low yield" experiments has an equivalent explosive power less than one kiloton of TNT. Depending on the weapon design, these experiments would vary over the range of four pounds of TNT up to one kiloton of TNT. Unlike hydronuclear experiments which are conducted for safety reasons, these experiments are designed to increase understanding of the explosive physics that occurs in the first stage of a "gas boosted" nuclear device.

> "In order to achieve higher explosive yields...with relatively small quantities of [fissile] material, a technique called "boosting" is used. Boosting is accomplished by injecting a mixture of tritium (T) and deuterium (D) gas into the pit. The deuterium and tritium are stored in reservoirs until the gas transfer system is initiated. The implosion of the pit along with the onset of the fissioning process heats the D-T mixture to the point that the D-T atoms undergo fusion. The fusion reaction produces large quantities of very high energy neutrons [14 million electron volts (MEV)] which flow through the compressed pit material and produce additional fission reactions." (47: 1-6)

These experiments do not have an official name. However, during this paper I will refer to them as "boost gas" experiments. As with previous "high yield" nuclear tests, "low yield" boost gas experiments would be conducted underground. In their report on *Nuclear Testing*, the

JASONs concluded "...testing under a 500 ton yield limit would allow studies of boost gas ignition and initial burn, which is a critical step in achieving full primary design yield." (29: 4)

The result of permitting hydronuclear and boost gas tests will be high confidence in the stockpile and the ability to upgrade its levels of safety and security. The high confidence stems from a more complete understanding of the physics and a superior ability to discover emerging problems. Increased safety and security result from the ability to incorporate improved safety and security features into stockpile weapons and to positively verify that they do not have unintended, negative impacts on either safety, performance, or reliability. For example, the U.S. would not seriously consider enhancing the safety of a nuclear weapon by installing a fire resistant pit without successfully verifying the design in an underground test. (11)

C. AREN'T 50 YEARS OF NUCLEAR TESTS ENOUGH?

The United States conducted more than 1000 explosive nuclear tests between the Trinity test on July 16, 1945 and the Divider test on September 23, 1992. (5: 4, 32) Russia (~700), France (~200), Great Britain (~50), and China (~50) conducted another 1000 tests. (30: 1) These tests were conducted in the atmosphere, in the ocean, and underground in order to learn about weapons physics, to gain confidence in aged stockpile weapons, to verify production processes, to determine weapon effects, and to perform basic science. (11 & 26: 2) Many supporters of the "zero yield" test provision point to this 50 year accumulation of test data and maintain that all of the necessary information exists to responsibly evaluate and manage the

enduring nuclear weapon stockpile. As an example, the JASONs published a report in 1995 in which they concluded:

> "The United States can, today, have high confidence in the safety, reliability, and performance margins of the nuclear weapons that are designated to remain in the enduring stockpile. This confidence is based on understanding gained from 50 years of experience and analysis of more than 1000 nuclear tests, including the results of approximately 150 nuclear tests of modern weapon types in the past 20 years." (29: 2)

As a result of different priorities and constrained testing budgets, only approximately 100 of the 1000 tests were fully instrumented to obtain physics data. (20) (See Figure 8: Physics Tests (Categories of Information Measured)) Although there are six general categories of

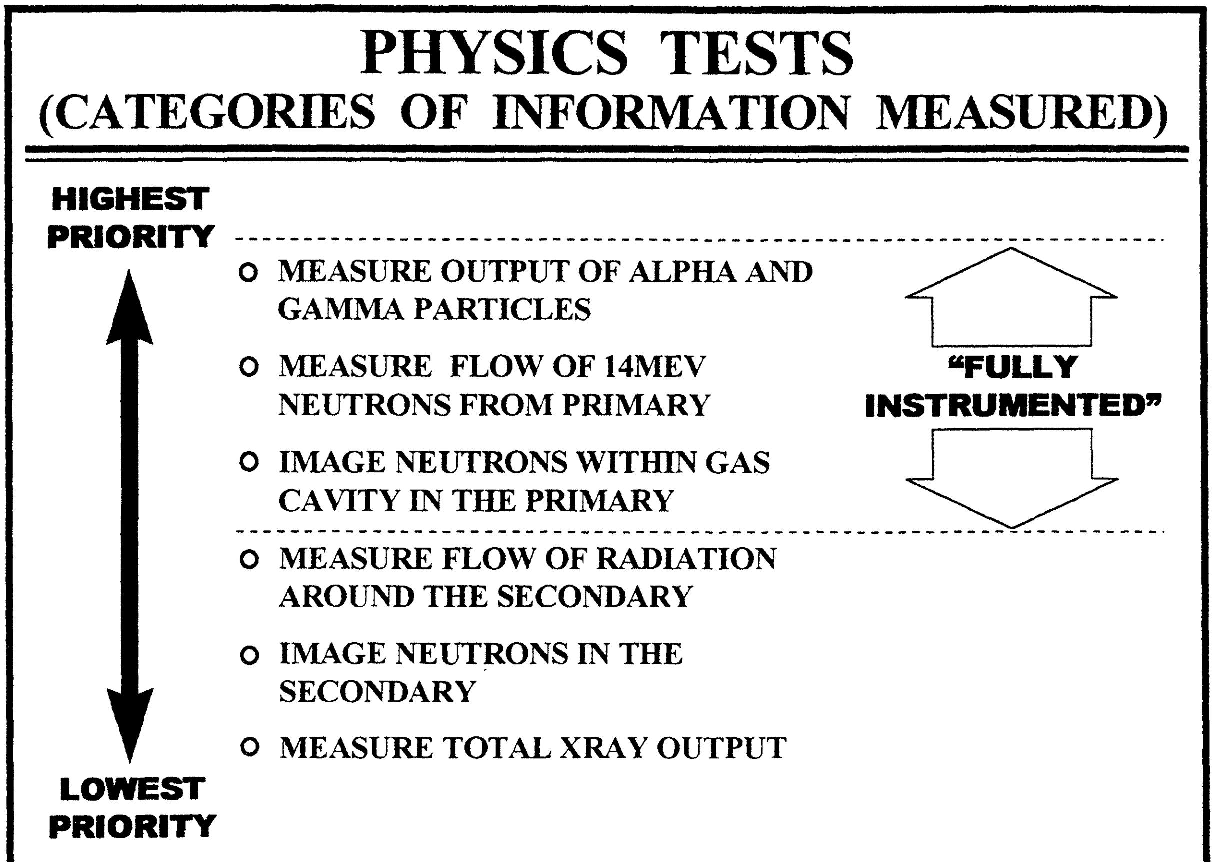

FIGURE 8 (11)

information that these physics tests measure, Mr. Cosimi stated that the fully instrumented criterion is met when the three highest priority tests are included. These physics tests measure the output of alpha and gamma particles, measure the flow of 14MEV neutrons from the primary, and image the neutrons within the gas cavity in the primary. Out of the 100 fully instrumented tests, only approximately 30 of them are pertinent to the nuclear weapon designs in the enduring stockpile. (11)

The reason for this very low number of physics instrumented tests is straight forward. Over the years of the testing program, the emphasis was placed on certifying weapons for entry into the active stockpile. (11) This resulted in testing dollars being focused on measuring whether or not the device worked. Only a relatively few dollars were spent on better understanding the physics involved. Additionally, weapons entered and exited the stockpile at a rapid rate. If a problem was discovered, it was corrected and another test was conducted. The life expectancy of a weapon in the active stockpile was approximately eight years. There was no pressing need to understand the impact of aging on the performance of the physics package because weapons did not remain deployed for more than about ten years. (20)

Throughout the nuclear age, explosive nuclear tests played a vital role in identifying problems within the nuclear weapon stockpile. Mr. Roger Batzel (Director, Lawrence Livermore National Laboratory) testified to the Senate Armed Services Committee in 1987 that, "Approximately one-third of all modern weapon designs placed in the U.S. stockpile have required and received postdeployment nuclear tests for resolution of problems. In three-fourths of these cases, the problems were discovered only because of the ongoing nuclear testing." (19: 4) Although this statement was made nine years ago, it raises serious questions about the efficacy of a "zero yield" testing provision. Included in this one-third of the stockpile were

NUCLEAR WEAPONS THAT REQUIRED NUCLEAR TESTING TO IDENTIFY OR CONFIRM PROBLEMS

WEAPON	PROBLEM	PROBLEM ORIGIN
	"THE 1960s NINE"	
B43	Performance with aged tritium (1962)	a
B28	Performance with aged tritium (1962)	a
W44	Performance with aged tritium (1962)	a
W45	Performance with aged tritium (1964)	a
W47	Neutron vulnerability (1962)	b
W50	Performance with aged tritium (1962)	a
W52	Improved HE safety (1962)	c
B57	Performance with aged tritium (1962)	a
W59	Performance with aged tritium (1962)	a
	"THE 1980s SIX"	
B61	Low-temperature performance (1981)	d
W68	Deterioration of HE (1980)	c
W79	Performance with new gas fill system (1982)	e
W80	Low-temperature performance (1981)	d
W84	Stockpile confidence--no problem anticipated (1984)	e
WXX	One-point safety concerns [CLASSIFIED] (1987)	Unspecified

a -- Effect of aged component not tested
b -- Vulnerability requirement not tested
c -- Significant modification made but not tested
d -- Environmental requirement (severe) not tested
e -- Production version not tested

FIGURE 9 (19: 16) & (26: 19)

15 weapon designs. Nine of the problems were discovered soon after the 1958-1961 Testing Moratorium and six of the problems were discovered between the period 1981 to 1987. (See Figure 9: Nuclear Weapons That Required Nuclear Testing to Identify or Confirm Problems) The circumstances leading to the initial nine postdeployment failures are often attributed to the speed at which weapons were rushed into deployment prior to the moratorium and to an inferior understanding of nuclear weapons. Aged components were not tested, vulnerability requirements were not tested, and significant modifications were made but not tested. The circumstances leading to the most recent discoveries have more direct application to the enduring stockpile. Significant modifications were made but not tested, severe environment requirements were not tested, and production versions were not tested. Information on more recent failures is not available. However, whatever the actual reason(s) for the problems, Mr. George Miller (Associate Director for Defense Systems, Lawrence Livermore National Laboratory) stressed in a report to Congress that, "The important point here is that in each case, the weapon was thought to be reliable and adequately tested when it entered the stockpile. Problems resulted from aging, from concerns about safety, from environmental effects, or from a later realization that our understanding of the weapon's physical behavior was incomplete." (26: 2-3)

The cost of prohibiting explosive nuclear tests must be viewed in its impact not only on the U.S. nuclear weapons stockpile, but also on the stockpiles of the other nuclear weapon states. The nuclear weapon states did not pursue identical tracks in their weapon design programs. Additionally, each nation incorporated the safety and security features that it determined to be necessary. As a result, the respective stockpiles are unique with respect to the physics package designs and the safety and security features. These fundamental differences require that the

modeling tools to assess safety, security, and reliability are also unique. When this problem is combined with the reality that the nuclear weapon states do not share the same level of computational and nonnuclear experimental capabilities, it seems prudent to predict that future problems will occur in the stockpiles and that assessment methods and tools will not detect them. Permitting "low yield" experiments will hedge against "unknown" gaps in modeling capabilities, will permit safety and/or security features to be added to nuclear weapons currently without them, will test the use of new manufacturing processes and materials (some may no longer be available), will validate computer codes as they are changed from one dimensional to two dimensional to three dimensional), and will add confidence in the reliability and capability of deterrent military forces.

D. CHAPTER HIGHLIGHTS

Modern nuclear weapons are extremely complicated devices that were designed to very tight tolerances in order to minimize weight and volume and to maximize explosive yield. In order to function properly, these multiple stage weapons rely on gas boosting of the primary stage to achieve the forces that are required to drive the secondary stage. In addition to the central physics package, modern safety and security standards include enhanced nuclear detonation safety (ENDS), fire resistant pits (FRP), insensitive high explosive (IHE), and use control features. However, few weapons in the enduring stockpile incorporate all of them. As with the U.S. nuclear stockpile, foreign stockpiles include a mixed bag of safety and security features.

Underground "low yield" experiments are conducted for two principal reasons. Hydronuclear experiments—explosive power less than four pounds equivalent TNT—are

conducted to evaluate the "one point safety" or "multipoint safety" of a nuclear weapon. "Boost gas" experiments—explosive power less than one kiloton equivalent TNT—are conducted to evaluate boost gas performance (ignition and burn). Both hydronuclear and "boost gas" experiments have implications for weapon safety, security, and reliability. Either by directly measuring it or by permitting highly desirable safety and security features to be incorporated confidently without a fear of unintended, adverse consequences or a loss of either reliability or performance.

Although the United States conducted approximately 1000 "high yield" nuclear tests over the past 50 years, only approximately 100 of them were fully instrumented to understand the primary stage physics. Only approximately 30 of these physics instrumented tests were performed on weapons in the enduring nuclear stockpile. Without "low yield" experiments to improve knowledge of physics within the primary, the Science Based Stockpile Stewardship program will lack an adequate baseline to develop its computer based modeling tools. Throughout the nuclear age, the historical record indicates that approximately one-third of all modern nuclear weapon designs required postdeployment nuclear tests to resolve problems. Nuclear tests played crucial roles in identifying these problems and verifying the solutions. In three-fourths of the cases, nuclear test results were the only reason that problems were discovered.

IV. SCIENCE BASED STOCKPILE STEWARDSHIP

A. PROGRAM DESCRIPTION

The Science Based Stockpile Stewardship (SBSS) program is "...a new approach to ensuring confidence in the U.S. [nuclear weapons] stockpile....It rel[ies]on scientific understanding and expert judgment, not on nuclear testing and the development of new weapons, to predict, identify, and correct problems affecting the safety and reliability of the stockpile." (40: 1-2) As a logical next step after the presidentially imposed nuclear testing moratorium, the President and the Congress directed the U.S. Department of Energy (DOE) "...to establish a stewardship program to ensure the preservation of the core intellectual and technical competencies of the U.S. in nuclear weapons." (40: 2)

SBSS is an aggressive program that requires substantial successes in a wide variety of technical and personnel issues. The original budget commitment to accomplish the assigned tasks was $4.0 billion per year for the first 10 years and $3.0 billion per year there after. (4) The $4.0 billion per year is required to build the extensive infrastructure and operate the various SBSS components. Once the infrastructure is in place, operations and maintenance costs remain. Although SBSS is often viewed as a family of technical challenges, these may in actuality present the least challenging hurdles. The very formidable combination of maintaining both personnel competencies and budgetary momentum over the long term may prove to be the eventual weak link in the SBSS program chain.

As specified in the directing documents, SBSS has three goals which it must achieve. (See Figure 10: Program Goals (SBSS)) SBSS must provide a "... high confidence in the safety, security, and reliability of the U.S. stockpile to ensure the effectiveness of the U.S. nuclear

PROGRAM GOALS

SCIENCE BASED STOCKPILE STEWARDSHIP

- **PROVIDE HIGH CONFIDENCE IN THE U.S. STOCKPILE WHILE SIMULTANEOUSLY SUPPORTING ARMS CONTROL AND NONPROLIFERATION**
- **PROVIDE A SMALL, AFFORDABLE, AND EFFECTIVE PRODUCTION COMPLEX**
- **PROVIDE THE ABILITY TO RECONSTITUTE U.S. NUCLEAR TESTING AND WEAPON PRODUCTION CAPACITIES SHOULD NATIONAL SECURITY DEMAND**

FIGURE 10 (40: 4)

deterrent while simultaneously supporting the U.S. arms control and nonproliferation policy." (40: 4) According to Mr. Michael Anastasio (Lawrence Livermore National Laboratory), "we will probably go backward before we are able to go forward." (3) The United States is in a very favorable position because of the current health of the stockpile. Nearly everyone agrees that it is in good shape. Therefore, the U.S. can probably afford the 10 year reduction in stockpile stewardship capabilities. Throughout the period, capabilities will increase incrementally as additional SBSS elements are brought on line.

Although many pundits claim that SBSS contains the necessary elements to provide high confidence in the enduring stockpile, its primary objective of maintaining an enduring nuclear stockpile for the United States runs directly contrary to the many organizations whose ultimate goal is worldwide nuclear disarmament. This characteristic of SBSS gives the well-founded impression that it is a means by which the declared nuclear powers retain their nuclear arsenals while excluding other nations who might wish to acquire them. Therefore, the political advantage of a "zero yield" testing provision pales by the reality that SBSS is designed to support a strong U.S. nuclear weapons program for the foreseeable future.

The second goal of the SBSS program is to provide a "...small, affordable, and effective production complex to provide component and weapon replacements when needed, including limited-lifetime components and tritium." (40: 4) This goal appears to be independent from the issue of "low yield" nuclear experiments. The U.S. Department of Energy has aggressively downsized the nuclear weapons complex throughout the 1990s. Whether "low yield" experiments are or are not permitted, the DOE must still retain a production capability that meets the challenges presented by the enduring stockpile. The principle linkage between the testing and producing efforts is perception. As the U.S. backs away from its commitment to the nuclear weapons program on any front, it becomes increasingly difficult to support it elsewhere.

The third and final goal for SBSS is to provide "...the ability to reconstitute U.S. nuclear testing and weapon production capacities...should national security so demand in the future." (40: 4) Although this goal is clearly stated, putting it into effect over the long term will be extremely difficult as budgetary pressures increase and threat perceptions evolve. Without an active nuclear testing program, U.S. personnel, expertise, and infrastructure capabilities will

surely atrophy. Reconstituting them at a later date may prove to be an extremely difficult problem.

The Department of Energy recognizes that SBSS presents serious challenges to the scientific and technical communities. However, the DOE has developed strategies to address the five critical issues that were identified. (See Figure 11: Scientific and Technical Issues (SBSS))

SCIENTIFIC & TECHNICAL ISSUES

SCIENCE BASED STOCKPILE STEWARDSHIP

- **MAINTAINING CONFIDENCE IN STOCKPILE SAFETY AND RELIABILITY WITHOUT NUCLEAR TESTING**
- **REDUCING THE VULNERABILITY OF THE SMALLER STOCKPILE TO SINGLE-POINT AND COMMON-MODE FAILURES**
- **PROVIDING AN EFFECTIVE AND EFFICIENT PRODUCTION COMPLEX FOR THE SMALLER STOCKPILE**
- **PROVIDING LONG-RANGE SUPPORT FOR THE ENDURING STOCKPILE**
- **ENSURING AN ADEQUATE SUPPLY OF TRITIUM**

FIGURE 11 (40: 4-5)

The first issue is SBSS must maintain confidence in the safety and reliability of the nuclear weapon stockpile without using underground nuclear testing. (40: 4-7) The DOE will upgrade or develop experimental and computational capabilities to replace those that were lost when the underground testing program was suspended. However, Dr. Jas Mercer-Smith (Deputy Program Director, Los Alamos National Laboratory) confirmed that some capabilities cannot be replaced. (24) The experimental capabilities will be achieved through an integrated family of

"Above-Ground Experiments." (See Figure 12: Above-Ground Experiments (AGEX)) At the same time, the Accelerated Strategic Computing Initiative (ASCI) is leading the way to increase

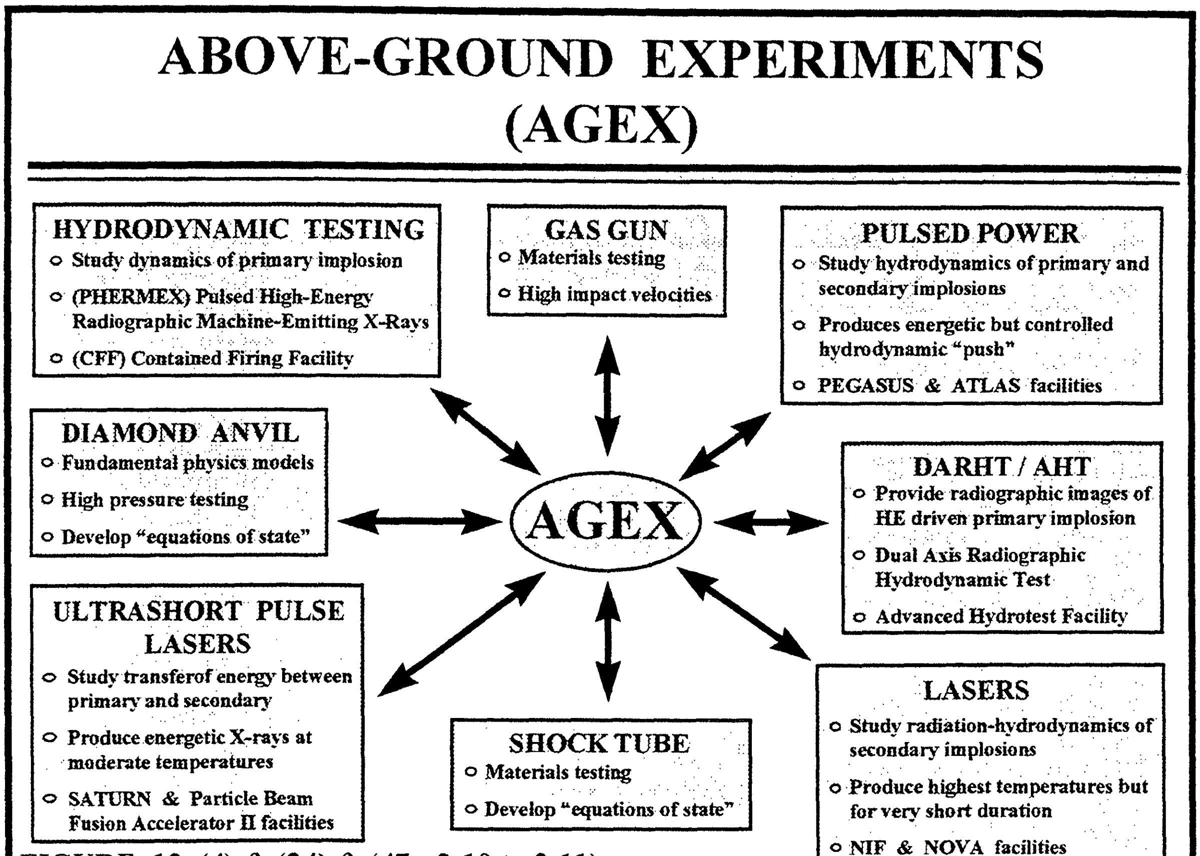

FIGURE 12 (4) & (24) & (47: 2-10 to 2-11)

computational speeds and storage by more than 1000-fold. Although new weapon production has ceased, ASCI is necessary to provide "the ability to design nuclear weapons, analyze their performance, predict their safety and reliability, and certify their functionality as they age." (2: 1) Without nuclear testing, there is no way to verify that the new computer codes are providing accurate answers. However, even assuming that all of these initiatives are successfully fielded, information gaps will remain and will introduce uncertainty into safety and reliability assessments.

The second issue is SBSS must reduce the vulnerability of the smaller stockpile to single-point and common-mode failures. (40: 5-8) Previous nuclear weapon stockpiles had as many as 25 unique weapon designs. The enduring stockpile will contain only seven weapon designs, although some designs have multiple modifications (e.g. B61 with Modifications 3, 4, 7, and 10). The fewer the number of unique designs, the more vulnerable the stockpile is to either a single-point or common-mode failure. Therefore, surveillance capabilities for designs and materials must be improved because the adverse impact of an undetected failure is greater than it would be in a more diverse stockpile. Mr. George Miller (Lawrence Livermore National Laboratory) stated that, "We must now be able to predict problems, not just find them after they happen." (25)

The third issue is SBSS must provide an effective and efficient production complex for the smaller stockpile. (40: 5, 9-11) The number of facilities in the nuclear weapon production complex has been reduced from seven to four (Kansas City Plant (Missouri), Pantex (Texas), Savannah River Site (South Carolina), and Oak Ridge Y-12 (Tennessee)). In order to meet this challenge, the DOE has strategies to develop advanced manufacturing and materials technologies. The smaller production complex must be able to respond rapidly and flexibly to correct problems that are discovered in the stockpile. The DOE must certify that "new" production processes result in products that are not only made to the original specifications, but are also "functionally" identical. (25)

The fourth issue is SBSS must provide long-range support for the enduring stockpile. (40: 5, 11-12) The focus of this issue is ensuring that the United States retains the option to develop new nuclear weapons if that action becomes necessary. In light of no new weapons being developed or produced, budgets being reduced, and an aging staff with actual nuclear

weapon design, production, and test experience, it will be difficult to attract and to retain outstanding personnel and to protect funding under increasing pressures to balance the federal budget.

The fifth issue is SBSS must ensure an adequate supply of tritium for the enduring stockpile. (40: 5, 12) All of the nuclear weapons in the enduring stockpile use gas boosting to increase the yield of the primary. The radioactive tritium gas that is used in this process has a 12.5 year half-life and decays at a rate of about 5% annually. Because it decays, it must be replaced periodically. The U.S. has not produced any tritium since 1988 and does not have the infrastructure in place to do so. Current supplies—including a 5-year reserve—will be exhausted in about 2011. The DOE is pursuing a program to develop a new source of tritium. However, it will take 10-15 years to bring it on line.

B. LONG-TERM IMPLICATIONS

Throughout the often intense debate over the issues of "low yield" nuclear experiments and SBSS, much of the discussion centered on our ability to dispense with "proof positive" experiments because alternative measurement methods were available or could be developed. At the same time, however, the scientific community argued that because of the large number of scientific and technical unknowns, major efforts needed to be launched across a wide array of disciplines. This obvious contradiction casts serious doubts on the confidence that should be attributed to system wide performance based on a collection of integrated SBSS measurements. The number of unknowns will always be such that piecemeal analytic tools—even though well designed and carefully integrated—cannot replace the assurance provided by actual testing.

However, the technical hurdles of SBSS will be dwarfed by the problem of sustaining programmatic momentum and support over the long-term. The original budgetary planning factors for SBSS were $4.0 billion for each of the first ten years and $3.0 billion thereafter. These were the funding levels that DOE and national laboratory personnel agreed to when they affirmed that they could accomplish the SBSS tasks. In the first three years of the program, annual funding has been approximately $3.5 billion (FY95), $3.7 billion (FY96), and $3.7 billion (FY97). In the first three years, the program has been underfunded by $1.1 billion. Although the Administration's FY98 budget has not been completed, sources which desire to remain anonymous indicate that staffers within the Office of Management and Budget are exploring the possibility of reducing FY98 funding to $3.0 billion.

In addition to budgetary pressures, political agendas at odds with the enduring U.S. commitment to nuclear weapons will attempt to undercut the SBSS program whenever possible. As an example, attempts are underway to prevent the DOE from conducting planned, sub-critical, underground tests at the Nevada Test Site. (4) These tests are necessary to improve understanding of implosion mechanics. They will violate neither the terms nor the intent of the "zero yield" CTBT. In addition, a court injunction disrupted construction of the Dual Axis Radiographic Hydrodynamic Test (DARHT) facility at Los Alamos, New Mexico. With these examples as tangible departure points, additional attempts to reduce the breadth of the stewardship programs should be expected.

Even if the 25% reduction does not materialize in FY98 or the sub-critical tests are not banned, these examples clearly demonstrate it will be exceptionally difficult to sustain programmatic momentum and support over the long-term. With each subtraction or delay in the SBSS program, additional uncertainty will be introduced into U.S. confidence in the safety and

reliability of the enduring nuclear weapon stockpile. This may be the intended result of nuclear disarmament advocates because they view this development as precipitating eventual disarmament.

C. IMPACT ON NONPROLIFERATION

The Science Based Stockpile Stewardship program sends contradictory signals to potential proliferant states. None of the declared nuclear weapon states has given any indication that they will relinquish their nuclear weapons stockpiles. To the contrary, these governments have reaffirmed the important deterrent roles that nuclear weapons contribute to their national security strategies. As an example, President Clinton used the opportunity of a statement on the Comprehensive Test Ban Treaty to say,

> "As part of our national security strategy, the United States must and will retain strategic nuclear forces sufficient to deter any future hostile foreign leadership with access to strategic nuclear forces from acting against our vital interests and to convince it that seeking a nuclear advantage would be futile. In this regard, I consider the maintenance of a safe and reliable nuclear stockpile to be a supreme national interest of the United States." (34: 1)

SBSS is the mechanism that the United States will use to accomplish this task. Although Administration officials repeatedly and steadfastly assert that the U.S. will not develop new weapon designs, skeptics throughout the world believe that "[SBSS] will be viewed by other countries, and especially by potential proliferators, as a very large, expensive commitment to nuclear weapons, and to the eventual possibility of new types of weapons." (39: 53) In another statement of displeasure with SBSS, the Western States Legal Fund wrote, "While demanding that other nations abandon their nuclear aspirations, the U.S. is continuing to legitimize nuclear

weapons as an instrument of national policy and is imposing an international double standard." (39: 54)

In addition to the messages that SBSS sends to the international community, there is a concern that SBSS will result in "nuclear weapon know-how" being exported to potential proliferants. With respect to this problem, the National Ignition Facility is the only SBSS above-ground experimental facility that will be open to international visitors conducting basic research. (39: 46) Therefore, the NIF is the key to determining the extent of potential export problems.

The mission of the NIF is to produce ignition and modest energy gain in Inertial Confinement Fusion (ICF) targets. If we assume that a proliferant nation seeking to develop —rather than purchase--a nuclear weapon capability would focus on a single-stage, non-boosted, first generation fission weapon, then the export danger is minimal because ICF technology lacks basic relevance for these types of devices. (39: 24) Although this assumption is pivotal to the risk assessment, it appears to be a reasonable one. The NIF is designed to provide useful information on the more sophisticated gas-boosted weapons. Therefore, the SBSS program should not pose a serious threat of exporting nuclear design information to non-nuclear states.

With respect to the states that already possess a nuclear weapon capability, Lawrence Livermore National Laboratory will exclude "researchers from certain categories of countries (e.g., non-adherents of the...NPT, states which have unresolved International Atomic Energy Agency...safeguards compliance issues, or other countries that the United States suspects are developing nuclear weapons." (39: 7) Although at first glance this appears to be a reasonable solution to the problem, I do not believe that it is. The NIF will be used for basic research on a wide variety of topics. Some of the computer codes that are used to predict behavior of ICF

targets have much in common with codes used to design boosted primaries and secondaries. Allowing foreign scientists to work at the NIF will increase the number of scientists who are knowledgeable about some of the basic physical processes that occur in nuclear weapons. (39: 3) In addition to the dual-purpose qualities of the NIF, it is unreasonable to assume that the research findings will not percolate throughout the international scientific community—potentially into the hands of individuals who would otherwise be prohibited from conducting their own research efforts at the facility. Therefore, banning undesirable persons or groups may not effectively block the transfer of sensitive—but unclassified--information.

In addition to the nuclear weapon states possessing weapons with unique designs and distinct safety, security, and use control systems, they also possess varying levels of stockpile stewardship capabilities. Although SBSS may provide the United States with confidence in its enduring stockpile, the lack of similar capabilities may preclude other nuclear states from arriving at similar conclusions. In justifying its underground nuclear test program, "China claim[ed] that it [did] not have the computer technology to undertake lab tests and that it need[ed] to test in the field." (6: 1) In a similar statement to justify the French testing program, Mr. Ren Galy-Dejean, author of the French National Assembly defense committee report on future French nuclear test simulation capabilities, said, "In things that are essential to national security, national egoism always wins out. We don't know who the future U.S. president will be. But it is my duty as a French responsible leader to consider our own notion of security, as well as to advance nonproliferation and the banning of nuclear weapons...France is seeking its own position." (15: 1) Therefore, although SBSS may prevent unexpected safety and reliability problems from going undetected in the U.S. enduring stockpile, the U.S. must be careful that a lack of equivalent capabilities does not result in unsafe foreign stockpiles.

D. CHAPTER HIGHLIGHTS

Science Based Stockpile Stewardship is a multi-billion dollar, multiple discipline program that is designed: a) to insure confidence in the safety and reliability of the enduring stockpile in the absence of nuclear testing, b) to provide a small, affordable, and effective production complex, and c) to provide the ability to reconstitute U.S. nuclear testing and weapon production capacities should national security demand. Although it faces significant technical challenges, the most formidable hurdles may well be sustaining programmatic and budgetary momentum over the long-term.

SBSS sends conflicting signals to the international community. The U.S. is actively pursuing a "zero yield" CTBT. However, SBSS represents a major investment in sustaining the world's largest nuclear weapons stockpile. This is at odds with Article VI of the NPT which calls upon the declared nuclear states to pursue negotiations in good faith leading toward nuclear disarmament.

The U.S. is probably in the best position to switch from underground nuclear testing to a stockpile stewardship program without nuclear testing. Not only is the U.S. nuclear stockpile in the best condition concerning safety, security, and reliability, the U.S. also possesses the greatest computer-based modeling and simulation capabilities. Confidence in the state of the U.S. stockpile provides the flexibility to field the various SBSS elements over a 10 year period. However, the other nuclear states are not positioned as favorably. U.S. comfort and reliance with SBSS must not result in unsafe, unsecure, or unreliable conditions developing in foreign nuclear weapon stockpiles.

V. POLITICAL CONSIDERATIONS

A. ANATOMY OF THE "ZERO YIELD" TESTING POLICY

Although the political dimension of President Clinton's "zero yield" testing decision is understandable when viewed within the Wilsonian framework that guides the Administration's foreign policy, the decision nonetheless contains major internal contradictions. These fundamental inconsistencies may eventually result in the Administration failing to conclude its proposed "zero yield" testing Comprehensive Test Ban Treaty. The "zero yield" testing pronouncement reflects a Wilsonian bias in foreign policy by this Administration. Unlike a raison d'état approach which is founded on protecting national interests, a Wilsonian approach relies on moral values to underpin American decisions and actions. In a letter of support from the U.S. Senate to the President, the 24 senators who signed the document congratulated him for "provid[ing] strong political leadership to counter proliferation around the globe... [and] set[ting] a powerful moral example to the other nuclear weapons states." (21: 1)

The thrust of the "zero yield" testing decision is to lead the international community by example. In this very specific case, the goal is that potential proliferant nations will eschew nuclear weapons programs in large part because the five declared nuclear states—including the United States—have ceased their nuclear testing programs. However, the potentially fatal disconnect in the policy is that none of the declared nuclear weapon states is going to eliminate its nuclear weapons. As described by the Pugwash Council, "The apparent failure of the nuclear weapon states to appreciate the implications of a "do as we say, not as we do" approach to the

future of nuclear weaponry can only be seen as a remarkable lapse in the application of logic to international affairs." (41: 3) India is leading the international effort to connect the CTBT with a commitment by the nuclear states to nuclear disarmament. "In early July, both India—on behalf of the Group of 21 Non-Aligned countries—and Indonesia put forward new draft texts for a CTBT aimed explicitly [at] prohibiting low yield tests." (38: 2-3)

Seriously complicating this discussion is the President's decision to include a "national interest" escape clause which will permit the United States to resume nuclear testing in the event of an emergency. Unlike the Wilsonian underpinning for the "zero yield" testing CTBT, the "national interest" escape clause is clearly a raison d'état foreign policy decision. If it is in the best interests of the declared nuclear weapon states to retain their nuclear arsenals, it is difficult to chastise non-nuclear weapon states for pursuing the same "advantages" that can be derived from national weapon programs. Mr. Frank Blackaby expressed these sentiments precisely when he wrote,

> "Why should nuclear weapons be necessary for U.S. security, and not also for the security of Israel, or India, or Pakistan? Indeed, the smaller states could argue that they have greater need for the equalizing power of nuclear warheads. If the present nuclear-weapon states persist in retaining their nuclear warheads indefinitely, then sooner or later other states will seek to join them as nuclear powers and will be successful." (1: 5)

B. DOMESTIC POLITICS

The domestic political stage is a complicated forum to debate any contentious issue. In the final analysis, it may prove extremely difficult for the United States Senate to ratify the CTBT treaty if the "zero yield" testing option is included. As a very tangible indication of a lack of bipartisan support, twenty-four U.S. Senators sent a letter to President Clinton urging him

"not to agree to demands ... to conduct additional tests or to change the U.S. negotiating strategy from... a truly comprehensive treaty to ban all tests." (21: 1) Twenty-two of the signers were democrats—while only two were republicans. Mr. John Isaacs described this situation by writing, "If the Republicans regain the White House in 1996 and maintain their majorities in Congress, past and future arms control treaties should be added to the endangered species list." (17: 7) When I discussed the matter with Ambassador James Sweeney (Special Representative of the President for Arms Control, Nonproliferation & Disarmament and Chief Science Advisor), he said that it would be difficult to gain Senate ratification and predicted that it would take three to four years to achieve. (36)

Within the Executive Department, the "zero yield" testing decision was hotly contested before final approval by President Clinton. During the final rounds of interagency debate, the Departments of State and Defense favored the "low yield" experiments option. The Headquarters of the Department of Energy and the Arms Control and Disarmament Agency favored the "zero yield" testing option. (24) The national laboratories favored the "low yield" option but were overruled by DOE Headquarters. (11) When the President decided upon the total ban on testing, he acknowledged the justified concerns of those who favored "low yield" experiments and included the safeguards which were previously discussed.

In supporting the "low yield" experiments option, some might argue that the Department of Defense was unable to break the shackles forged by 50 years of nuclear testing. However, it should be remembered that the continued organizational health survival of the DoD does not depend on "low yield" nuclear experiments. The DoD evaluated the alternatives and determined that although previous tests do provide a wealth of information by which to assess the safety, the security, and the reliability of the U.S. enduring nuclear stockpile, these weapons have never

been exposed to the rigors of aging—many of which are unknown. Each type of weapon is a unique, extremely complicated, engineering marvel designed to highly optimized tolerances. The previous large scale testing programs were conducted to both assess existing inventories and validate new weapon designs. These tests typically varied between 10s of kilotons and 150 kilotons. Conducting "low yield" experiments with less than one kiloton of yield would permit the declared nuclear weapon states to responsibly evaluate their nuclear weapon stockpiles but would not permit them to develop new, advanced weapon designs. This significant change to the weapon testing programs would freeze weapon technologies at their current levels of sophistication and would permit the enduring stockpiles to be managed responsibly.

Between the Department of Energy and the Department of Defense, the DOE position supporting the "zero yield" testing option is the more politically entwined. For the past 50 years the Department of Energy—and its predecessors—staunchly argued the imperative of continuing the "large scale" nuclear testing program. The relevant argument focused on responsibly managing the stockpile given the large body of unknown information concerning aging effects. The DOE's total reversal on this issue deserves deeper scrutiny.

From one viewpoint, the change can be explained as the result of new technologies becoming available and permitting alternative assessment methods in lieu of nuclear testing or experimentation. These technologies are the basis of the Science Based Stockpile Stewardship program. While it is certainly true that many new capabilities have been developed, none of them will provide the absolute certainty afforded by a nuclear experimentation program.

From another viewpoint, the change can be explained as a means to advance the bureaucratic longevity of the Department of Energy by requiring a $70 billion expenditure of funds over the next 20 years to develop and to operate a new generation of diagnostic tools.

Without the justification of replacing the nuclear testing program, it would be much more difficult to obtain these dollars as pressures increase to reduce government spending and balance the federal budget. A skeptic might justifiably characterize the SBSS program as a means by which the Department of Energy scientists can obtain a new generation of sophisticated hardware.

Another troubling aspect of the "zero yield" testing debate was the decision to retain both Los Alamos National Laboratory and Lawrence Livermore National Laboratory as physics labs for the nuclear weapons program. As one of its principle recommendations, the Galvin Commission wrote that the Department of Energy should downsize to one nuclear design laboratory. Lawrence Livermore National Laboratory [LLNL] should "transfer... its activities in nuclear materials development and production to [Los Alamos National Laboratory]. LLNL would transfer direct stockpile support to the other weapons laboratories." (46: 63) Los Alamos should be that lab. By eliminating the need to develop new weapon designs, a smaller, more efficient program to manage the existing stockpile could be consolidated at one laboratory. Again, in light of the political difficulties that arose in Northern California following the recent rounds of base closures and realignments by the Base Closure and Realignment Commission (BRAC), a skeptic might propose that the Lawrence Livermore decision and SBSS dollars were political and economic compensation to offset the adverse impacts of the BRAC decisions.

The probability of Senate ratification is open to conjecture. Unlike previous nuclear-related treaties that either specified the number of permitted weapons or restricted how they were tested, the eventual long term result of the "zero yield" testing provision will likely be nuclear disarmament. Considering the very significant national security implications of such a result, the Republican dominated Senate may be unwilling to ratify a CTBT that prevents

positive verification of the U.S. nuclear weapons stockpile. In light of the difficulties in verifying worldwide compliance with a total ban on any form of nuclear testing, the risks of failing to deter and to detect a proliferant nation outweighs this symbolic gesture. Although the Administration is actively pursuing signature and ratification prior to the 1996 national elections, it appears to be an overly optimistic timetable that cannot be kept.

C. INTERNATIONAL POLITICS

> "No country without an atom bomb could properly consider itself independent."
> - Charles de Gaulle, May 12, 1968 (10)

Although many nuclear disarmament advocates would probably wish otherwise, the fact remains that there are people in this world who believe that possessing nuclear weapons enhances the opportunities for national security and levels an unbalanced playing field. This includes the undeclared nuclear weapon states as well as those states actively pursuing nuclear weapon capabilities. Whenever the subject of a "zero yield" CTBT is discussed, one must always remember that the core values, interests, and beliefs of the United States are not universally shared among the nations of the world. To the contrary, many nations hold views that are diametrically opposed to those of the United States.

The international political arena is no less complicated than the domestic. Almost any nuclear weapons issue is a surefire volatile subject that will make it to the front pages of the major newspapers. During 1995, the subjects of French nuclear testing, Chinese nuclear testing, and indefinite extension of the Nonproliferation Treaty generated considerable news media coverage. Although these developing stories might serve to frame the discussion on the CTBT and the "zero yield" testing provision, a strong linkage may or may not exist.

Both the Chinese and the French nuclear test programs were comprised of large yield, underground tests. They were comparable to previous U.S. nuclear tests conducted at the Nevada Test Site within the provisions of the Limited Test Ban Treaty and the Threshold Test Ban Treaty. Unlike the purpose of "low yield" experiments, the primary purpose for these testing programs was to modernize the Chinese and the French nuclear weapon stockpiles. "China's…testing program is thought to involve warheads for two new missile systems, one for deployment in the late 1990s, and one around 2010." (6: 1) The French tests were "likely to provide data not only for new nuclear weapon systems such as warheads for the new M45 and M5 submarine-launched ballistic missile and a new air-launched cruise missile, but also for future low yield, high powered laser experiments and computer simulation tests." (38: 1) As Mr. John Holum described it, "When the world is in the process of eliminating, dramatically reducing their nuclear weapons, no country really needs to be modernizing and updating their nuclear capabilities." (7: 2) "Low yield" experiments would maintain confidence in an existing stockpile but would not lead to new weapon designs. Traditional underground tests and "low yield" experiments are conducted for different reasons. The current maximum nuclear yield of permitted underground nuclear tests is 150 kilotons. Unlike these tests, the "low yield" experiments would be limited to an explosive power somewhere between four pounds equivalent TNT and one kiloton. The potential environmental dangers of these drastically reduced experiments are significantly less than the previously permitted large yield tests.

An interesting trend in the protests that resulted from the Chinese and the French tests was the different approaches that were taken in each case. Although I have not conducted an empirical study of the protest campaigns, I did read extensively the literature that was available. This included campaigns by Greenpeace, International Freedom, International Pugwash, and

Nation of Hawai`i. My initial assessment is that more attention was paid to the French tests than to the Chinese tests. As a result, more energy was expended to stop the French program than the Chinese program. The question that arises from this is, "Why did this difference occur?" If it was because the French tests were more threatening or dangerous, then it is understandable and does not have serious implications against the "zero yield" experiments provision. However, if it was because of the recognition that the Chinese were more likely to ignore international pressure and act in their perceived national security interests, then similar situations may arise in the future whenever a nation judges nuclear testing to be a primary national security interest. In both the French and Chinese cases, the conclusion can be logically drawn that nations will act in their interests even in the face of concerted international protest. At the same time, one should be careful not to draw unsupported inferences from the French and the Chinese tests.
Mr. Damon Moglen (Greenpeace anti-nuclear campaigner) stated that the French and Chinese testing programs "put pressure on all nuclear weapon states to test or fall behind these two countries in their game of nuclear one-upmanship." (16: 2) When the composition and sophistication of the U.S. and Russian nuclear stockpiles are compared to the French and Chinese stockpiles, neither the U.S. nor Russia would feel the need to increase their stockpiles or develop new weapon designs. The U.S. and Russia are more concerned with maintaining the safety, security, and reliability of their existing stockpiles. As to Great Britain's response, you can expect that Great Britain will follow the U.S. lead.

The Administration's most urgent nonproliferation foreign policy goal for 1995 was the indefinite and unconditional extension of the Nonproliferation Treaty. Although the NPT was extended, Under Secretary of State Lynn E. Davis recognized that it was not a reasonable expectation to believe that proliferant nations would dismantle their nuclear stockpiles.

However, the Administration was working very diligently to persuade these governments to do so. (37: 1-5)

As with many major decisions, the technical issues are dwarfed in comparison to the political ones. Even if one assumes that all of the technologies can be developed to verify the safety, reliability, and security of the existing nuclear stockpiles, the most difficult political questions remain. Are the declared nuclear weapon states prepared to disarm? Will potential proliferant nuclear states restrain weapon development even if they determine it to be in their national interests?

Verifying treaty compliance with a cooperative Russian Federation is very different than verifying treaty compliance with an uncooperative—and often hostile—North Korea, Iran, Iraq, or Libya. In the case of the "zero yield" prohibition, long range sensors cannot confidently detect treaty violations less than one kiloton. In addition, on-site inspections, portal perimeter monitoring systems, and other "transparency" measures require openness and cooperation by the participating nations. Even then, it becomes very expensive to conduct these types of verification activities over the long-term. With respect to ensuring nuclear nonproliferation, the long term may be a very, very long time.

In the aftermath of Desert Storm, one of the often asked questions is, "How would the event have played out if Iraq had a nuclear weapon?" In a briefing on nonproliferation, Mr. John Holum (Director, U.S. Arms Control and Disarmament Agency) stated, "If you want to think how important it [nonproliferation] is, think of what the Gulf War would have been like if Iraq had acquired nuclear weapons prior to that conflict." (28: 1-2) Considering U.S. concerns over this possible scenario, we cannot assume that this important lesson has been lost on our

potential enemies. Especially when it is combined with a treaty that includes a major provision that cannot be confidently verified.

D. REFINING THE COURSE

The Clinton Administration should refine its position on a "zero yield" CTBT. It should support a policy permitting "low yield" nuclear experiments within a CTBT and pursuing a tailored SBSS program that takes advantages of its best features and capabilities. The overall costs of such a program would be comparable to the currently planned SBSS program. (20) However, it would regain the critical capabilities and confidence that would be lost under the "zero yield" testing provision.

It may be politically difficult for the Clinton Administration to refine its position on a "zero yield" CTBT. Especially since the Administration considers the "zero yield"-"low yield" debate to be a dead issue. (36) Anytime an Administration alters a policy, there is a danger that its supporters—inside and outside of the Administration--will attempt to sabotage the change, regardless of its merits. However difficult it may be, Administrations do "refine" their policies. In this case the original "zero yield" decision was not universally applauded. "Zero yield" was primarily a political decision that attempted to compensate for its weaknesses by instituting a Science Based Stockpile Stewardship program.

The problem is that the total "zero yield" CTBT/SBSS package will not achieve its objectives. Although the President affirmed the importance of nuclear weapons in the national security strategy and the intention to retain an enduring nuclear stockpile, "zero yield" will prevent many safety and security features from being incorporated into the stockpile and will not prevent potential proliferant nations from developing nuclear weapons. Few of the nuclear states

are as favorably positioned to cease nuclear "testing/experimentation" activities as the United States. The "low yield" experiments option is less likely to result in an unsafe, an unsecure, or an unreliable condition developing in any of the world's nuclear stockpiles and being undetected.

If the Administration is incapable of revising its course, then other government bodies should come to the rescue. In the event that difficulties arise during treaty negotiations and universal support does not materialize, the Administration should not become so attached to the "zero yield" CTBT that it proceeds with significant nations absent in the hope that they would accede to the treaty at a later date. This is not a situation where "half a loaf" is better than none at all. If a "zero yield" CTBT is signed, the Senate should not ratify it. If a new Administration is elected, then it should review the current position and decide on this refined policy.

E. CHAPTER HIGHLIGHTS

As with many other major governmental decisions, the Clinton Administration selection of the "zero yield" testing option was dominated by political considerations. It represented a Wilsonian approach to foreign policy formulation in which moral values took precedence over national interests. The Administration hoped that U.S. leadership on this issue would persuade other nuclear states and potential proliferant nations to follow the U.S. example.

Unfortunately, the policy is flawed in large part because these other nations do not share the same values, interests, and beliefs as the United States. The United States views the "zero yield" CTBT/SBSS effort as a means to halt nuclear proliferation efforts while simultaneously freezing weapon technologies at their current levels. The effort is not a commitment to nuclear disarmament. This qualitative freeze does not answer the demands of disarmament advocates

who desire the nuclear states to dismantle their arsenals. When this "freeze-dismantlement" disconnect is combined with the "national interests" escape clause, the nuclear "have not" states have even less incentive to forego acquiring nuclear capabilities if they determine that course to be in their national interests.

The prospect of gaining Senate ratification of a "zero yield" CTBT is moderate to low. Political inconsistencies and the inability to verify the "zero yield" provision will make it very difficult for the Senate to support it. Although the President is on a fast track to get the CTBT signed before the U.S. presidential election in 1996, the ratification process will probably take three to four years to resolve.

The Administration should refine its position on a "zero yield" CTBT. It should support a policy permitting "low yield" nuclear experiments within a CTBT and pursuing a tailored SBSS program that takes advantages of its best features and capabilities. The overall costs of such a program would be comparable to the currently planned SBSS program. However, it would regain the critical capabilities and confidence that would be lost under the "zero yield" testing provision.

VI. SUMMARY

Arms controllers have sought a Comprehensive Test Ban Treaty for decades. Throughout their intense pursuit of this goal, much of the debate has focused on defining which, if any, tests should be permitted. The choice between setting the lower limit at "low yield" (explosive power less than one kiloton equivalent TNT) or "zero yield" (no explosive power) levels is not without judgment. Both options offer advantages and disadvantages which must be carefully weighed in light of continuing U.S. national security interests. Although President Clinton announced the United States will pursue a CTBT with a "zero yield" nuclear testing provision, he acknowledged the potential dangers of this decision by simultaneously directing a series of six safeguard measures to reduce the risk. After carefully evaluating the elements in the "low yield" versus "zero yield" debate, I will now summarize the pros and cons and assess their impacts on which option is in the nation's security interests.

The Requirement for Nuclear Weapons

In one study after another, the United States has stated that maintaining nuclear deterrent forces is a vital national interest. Although nuclear disarmament advocates would prefer that the United States, Russia, China, France, and Great Britain—as well as the undeclared nuclear weapon states--dismantle their nuclear stockpiles, these weapons will remain on the international landscape for the foreseeable future. Additionally, nuclear weapons science and technologies are permanent features—they cannot be undiscovered.

With enduring nuclear weapon stockpiles as the point of departure, national security decision makers should craft a CTBT that permits nations to responsibly manage their nuclear arsenals while simultaneously discouraging proliferation. As with previous nuclear arms treaties, a CTBT must be verifiable. It should not present a false impression that it ensures something that it cannot ensure. Technologies do not exist to monitor testing activities with an equivalent explosive power of less than one kiloton TNT. Neither are technologies anticipated in the future. A "zero yield" CTBT is not verifiable, while a "low yield" CTBT is verifiable.

ASSESSMENT: "Low Yield" experiments provision is preferable to "Zero Yield."

Technical Considerations of Nuclear Tests and Experiments

Modern nuclear weapons are exceptionally complex systems. Unlike early single-stage weapon designs, modern thermonuclear nuclear weapons incorporate multiple stages which operate on very thin margins for error because of the constant operational pressures to reduce weight and volume while maintaining explosive power.

"Low yield" experiments are comprised of hydronuclear experiments (< four pounds equivalent TNT) and "boost gas" experiments (< one kiloton equivalent TNT). Hydronuclear experiments test the safety of nuclear weapon designs. Boost gas experiments measure the signals that the boost gas in the first stage of a thermonuclear weapon ignites and burns.

Throughout the nuclear era, the U.S. testing program focused on certifying new weapon designs for the deployed nuclear weapon stockpile. Out of the approximately 1000 tests that the United States conducted, only approximately 100 of them were fully instrumented to better understand the physics of the first stage. To make matters worse, only approximately 30 of them were conducted on weapon designs in the enduring stockpile. Based on projected weapon life

spans and budgetary pressures, these decisions were prudent. Unfortunately, the result is a lack of safety and physics information at the level of detail needed to maintain the seven weapon designs in the enduring stockpile under a CTBT. Hydronuclear and "boost gas" experiments provide this vital information that is necessary whether the stockpile changes due to aging or to modifications which improve safety or security (not explosive power). Although non-nuclear tests can infer some of these results, they do not provide the same degree of confidence in stockpile weapons.

ASSESSMENT: "Low Yield" experiments provision is preferable to "Zero Yield."

Science Based Stockpile Stewardship

The Science Based Stockpile Stewardship program is the Headquarters, Department of Energy's response to termination of the underground testing program for U.S. nuclear weapons. As one of the safeguards directed by the Administration, SBSS goals are to provide high confidence in the enduring stockpile while simultaneously supporting arms control and nonproliferation; to provide a small, affordable, and effective production complex; and to provide the ability to reconstitute U.S. nuclear testing and weapon production capacities should national security demand.

SBSS is not without challenges or risks. Even assuming that the Department of Energy will overcome the technical aspects of the various unproven elements of SBSS, the difficulty of attracting and maintaining top-notch nuclear weapon scientists and technicians, and the anticipated annual assaults on the Department of Energy budget in the name of balancing the federal budget, SBSS will not replace the capabilities that are lost if "low yield" experiments are

not permitted. However, I must believe that the elements of SBSS will be fielded and will be protected for as long as the nation needs them.

Considering its impact on nonproliferation, SBSS presents the risk of exporting nuclear "know how" to potential proliferant states. However, with stringent safeguards, these risks can be mitigated and the threat reduced.

ASSESSMENT: "Zero Yield" testing provision is preferable to "Low Yield."

Political Considerations

Although a "zero yield" CTBT may be a noble moral gesture in the best traditions of Woodrow Wilson, the reality is that the rationale for the treaty is inconsistent and that the objectives are viewed radically different by the various members of the international community. The United States views a "zero yield" CTBT as a moral gesture leading the international community into a future less threatened by nuclear weapons. By our example, potential proliferants will be discouraged from pursuing nuclear weapon development. We view this treaty as a "qualitative freeze" for the declared nuclear states and a "quantitative freeze at zero" for all other nations. At odds with this position, many significant members of the community view this treaty as a "commitment to nuclear disarmament" by the declared nuclear weapon states. They do not accept the positions of the declared nuclear states that nuclear weapons are still required for their national security.

With respect to the experiences of recent Chinese and French nuclear tests, and the exporting of nuclear weapon development technologies from China to Pakistan, the United States can expect nations to act in their national interests. Even in the face of significant international pressure, these states acted as they judged most appropriate. The "zero yield"

ASSESSING CTBT TESTING PROVISIONS "LOW YIELD" VS "ZERO YIELD"

	"LOW YIELD"	"ZERO YIELD"
REQUIREMENT FOR NUCLEAR WEAPONS	✓	
NUCLEAR TESTS AND EXPERIMENTS	✓	
SCIENCE BASED STOCKPILE STEWARDSHIP		✓
POLITICAL CONSIDERATIONS	✓	
OVERALL ASSESSMENT	✓	

FIGURE 13

testing provision will not deter a nation that chooses to develop nuclear weapons and it cannot be verified.

The political problem with the "zero yield" CTBT is that the nations of the world do not share a common set a values nor do they have identical interests. The repeated examples of North Korea, Iraq, Iran, Libya, Pakistan, India, South Africa, and Israel clearly demonstrate that nations will pursue their national interests. Nuclear technologies cannot be "uninvented." When these experiences are combined with the "zero yield" provision that is not verifiable, the end result is increased uncertainty in the state of nuclear weapon stockpiles throughout the world.

ASSESSMENT: "Low Yield" experiments provision is preferable to "Zero Yield."

VII. CONCLUSION

The United States should pursue a Comprehensive Test Ban Treaty that permits "low yield" nuclear experiments. Combined with the indefinite extension of the Nonproliferation Treaty, this matched pair of treaties would be the most reasoned means to safely and securely manage the existing nuclear weapon stockpiles and to discourage further nuclear proliferation. Although it may be politically difficult for the Clinton Administration to publicly refine its Wilsonian position on "zero yield" testing, such a course correction would be in the best interests of the nation. By permitting these experiments, the United States could better ensure the safety, security, and reliability of its enduring nuclear weapons stockpile. This includes both measuring and assessing aging effects and certifying safety and security modifications. Additionally, allowing "low yield" experiments recognizes the reality that the "zero yield" provision is not verifiable.

Although some circles view the CTBT process as a vehicle to achieve worldwide nuclear disarmament, the United States has repeatedly declared that nuclear weapons remain central to its national security. The five announced nuclear weapon states view CTBT as a "freeze on developing new weapon types," and not a referendum on nuclear weapon disarmament. Combining "low yield" experiments with a tailored, reduced Science Based Stockpile Stewardship program would provide the Departments of Energy and Defense with the necessary tools to responsibly manage the enduring nuclear weapons stockpile. Although the total cost of this redefined stockpile management program would remain at the SBSS level, the increased confidence would be a better use of the money.

As is evident by the experiences of Chinese and French nuclear weapon testing; and Iraqi, Iranian, Korean, Pakistani, and Israeli nuclear weapons development programs, the corollary that "zero yield" testing will prevent future testing or proliferation does not follow. These examples, as well as the U.S. "national interests" escape clause clearly indicate that nations will pursue their vital interests. Although "zero yield" testing is an admirable moral statement, it is not verifiable. "Zero yield" testing introduces unnecessary uncertainty into the world's confidence in U.S. nuclear deterrent forces.

The Administration's desire to complete CTBT actions prior to the November 1996 elections is understandable. However, the Administration should take advantage of problems in the CTBT negotiations to slow the process and to restructure its position on "low yield" experiments. If a "zero yield" CTBT is signed, the Senate should not ratify it. If a new Administration is elected, then it should review the current position and decide on the proper course of action.

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